The Measurement of Sociometric Status, Structure and Development

By

URIE BRONFENBRENNER

School of Education
University of Michigan

360
M825

Beacon House, 1945
SOCIOMETRY MONOGRAPHS, NO. 6

866/17-12

The Measurement of Sociometric Status, Structure and Development

By

URIE BRONFENBRENNER

School of Education
University of Michigan

BUREAU OF EDNL. & PSYL. RESEARCH
LIBRARY

Bureau Ednl. Research
COLLEGE
Dated 17. 12. 55
Accs. No 866

Beacon House, 1945
SOCIOMETRY MONOGRAPHS, NO. 6

S.C.E.R.T., West Bengal
Library
Calcutta
25/3, B. C. Road

360
m 835

.E R.T.. West Bengal
te ....
c. No.....................

Copyright 1945
Beacon House, New York

23.12.57
223

First Published in SOCIOMETRY
Volume 6, No. 4, 1943
Volume 7, No. 1 and 3, 1944

PART I. A CONSTANT FRAME OF REFERENCE FOR SOCIOMETRIC RESEARCH[1]

I. INTRODUCTION

The emphasis of modern educational theory on the socio-emotional aspects of human growth has imposed the necessity of devising techniques for evaluating the degree and character of social development. The problem has been complicated by the fact that social development applies not only to the individual but also to the social organization of which he is a part. Variations occur not only in the social status of a particular person within the group, but also in the structure of the group itself—that is, in the frequency, strength, pattern, and basis of the interrelationships which bind the group together and give it distinctive character. Social status and structure are of course interdependent, but attention must be given to both of these variables if the process of social development is to be properly understood.

One of the most ingenious devices for the study of social status and structure is the sociometric test. This technique permits the analysis of a person's position within the group; it also makes possible an analysis of the framework of the group organization—an identification of persons dominant in the group structure, of cliques, of cleavages, and of patterns of social attraction and repulsion.

It is to be expected that so revealing a technique would be widely accepted and would yield valuable results in the study of social phenomena—particularly in the investigation of social development as indicated by change in status and structure. Moreover, in the light of the emphasis upon the individual found in modern psychological and sociological thought, it is to be expected that the results obtained through sociometric research would be evaluated not only in terms of the technique itself, but also in relation to other experimental and clinical data with the aim of securing a better understanding of the human organism and its growth.

---

[1] Grateful acknowledgment is extended to those members of the faculty at the University of Michigan whose guidance and coöperation have made this study possible: Drs. Irving H. Anderson, Norman R. F. Maier, Clark Tibbitts, Clifford Woody, and Paul Dwyer. Particularly, the writer wishes to express his indebtedness and appreciation to Drs. Willard C. Olson and William Clark Trow for their patient counsel and keen, painstaking criticisms.

While it has been the writer's observation that neither of these expectations has been fully realized, the first is the one which receives major emphasis, for the conclusion was reached that among the principal obstacles to a more fruitful utilization of the sociometric method are certain technical inadequacies. It is the purpose of this paper to indicate the specific character of these inadequacies, to suggest means for overcoming them, and to apply the more refined techniques which have been developed in an illustrative and exploratory study.

II. PRINCIPLES AND METHODS

Definition. The approach to social relations adopted and developed in the present study is that outlined by Moreno (13)[2] in the monograph *Who Shall Survive?* In this volume, the technique and its theoretical bases and interpretations are treated collectively under the term *sociometry*. As defined by Moreno (13:432), sociometry is "the mathematical study of psychological properties of populations, the experimental techniques of and the results obtained by application of quantitative methods."

In view of discussions by Moreno (18) and Jennings (7), the writer has been led to rephrase the original definition in somewhat more specific terms as follows: *Sociometry is a method for discovering, describing, and evaluating social status, structure, and development through measuring the extent of acceptance or rejection between individuals in groups.*

The significance of this definition, its implications and applications, will become evident in succeeding sections of this paper which present in effect a methodological critique of sociometric research.

Historical Background and Source Materials. The historical background of the sociometric method is outlined by Moreno (13:7-10). The volume *Who Shall Survive?*, already cited, represents the primary source and contains the most comprehensive account of sociometric theory, techniques, practice, results and implications. Subsequent developments have been reported extensively and routinely in *Sociometry: A Journal of Inter-Personal Relations* (25) published quarterly. A valuable collection of early definitive studies is contained in the *Sociometric Review* (26). New sociometric methods, especially valuable in the study of the individual are recently reported by Jennings in *Leadership and Isolation* (7).

Basic Methodology: the Sociometric Test. While the sociometric method incorporates several devices (7, 13), its fundamental technique is the *sociometric test*. This device is defined by Moreno (13:13) as follows "The sociometric test consists in an individual choosing his associates for any group of which he is or might become a member."

---

[2] Numbers within parentheses refer to the bibliography. The figures preceding the colon identify the work by number; when necessary, these are followed by the appropriate page reference.

Quantitative Significance of Elements. It is readily apparent that most of the elements and characteristics found in group structure are important quantitatively as well as qualitatively. Thus Moreno has used the number of isolates, mutuals, and unreciprocated choices as indices of group coherence (13). Similarly, the frequency of inter-sex or inter-race choice[3] has been used as an estimate of cleavage (3, 13). Moreover, Jennings' exploration of the choice process has disclosed that the social atom itself exhibits various patterns resulting from the way the choice process operates between persons in a community; and these patterns in turn are related to the general behavioral picture of the individual interacting with other group members (7).

Application of the Method. The sociometric technique has been applied in a variety of social situations. Studies have been made in classrooms (2, 3, 13, 29) factories (3), camps (8, 22, 24), fraternities (27), and entire communities (7, 10, 11, 12, 13). Approaches have been both analytic and constructive; efforts have been made not only to discover social relationships but to determine them as well (5, 13). The structuring of social groups and communities has been uncovered (7, 9, 13, 28) and ingenious therapeutic techniques have been developed (2, 13, 14, 15, 16, 18, 19, 20).

However, while a great deal of research material has been accumulated within the past ten years, many areas of investigation remain unprobed. In the following section several of these areas are discussed and factors impeding further progress are indicated.

III. The Present Status of Sociometric Research

The Character of Initial Progress in a New Field. It is to be expected, indeed it is in large measure inevitable, that in the development of a new field, attention must be limited at first to the study of the more elemental units. Only after the characteristics of such units have been identified is it possible to expand the scope of research so that that unit is viewed in new dimensions and new interrelationships.

---

[3] Criswell's extensive treatment of race cleavage will interest readers in connection with the present study, quite aside from the major import of her findings, because of its contribution in developing methods for measuring sociometric phenomena. Only for economy of presentation, discussion of Criswell's techniques for determining cleavage has been omitted here.

Untried Areas and Approaches in Sociometric Research. It is understandable, then, that sociometric research, in its first decade, should have been confined primarily to the study of status and structure within single social groups viewed at a given point in time. As a result, however, certain problems of more extensive scope have failed to receive broad consideration. The question of *change* in social status and structure has been treated principally from the point of view of cross-sectional rather than longitudinal studies (13). With the exception of the work of Jennings (6, 7), relatively little attention has been given to change within the same group over a period of time.[4] Thus the basic criterion for modern studies in development has seldom been satisfied and many challenging problems remain.

In preliminary experimentation with the sociometric technique, the writer was impressed with two major inadequacies in methods of presenting and analyzing data. These inadequacies may be grouped under the following captions: (a) the need of methods for identifying statistically significant data; (b) the need of methods for describing and comparing relationships in diverse sociometric situations.

The Need of Methods for Identifying Statistically Significant Data. It is somewhat paradoxical that the authoritative and comprehensive work in a field defined as a "mathematical study" should make no reference to the fundamental question of mathematical significance. It is not from the point of view of skepticism but rather from that of scientific rigor that the question is raised: to what extent are the results of sociometric testing statistically significant; or, to state the problem in somewhat more mundane terms, to what extent is the distribution of choices obtained in a sociometric test at all different from that which would be secured by having blindfolded subjects draw names from a hat.

With due justice, it should be stated that this problem has been raised, and solutions suggested, by Moreno and Jennings (21) in an article published subsequent to the appearance of the initial monograph. A discussion, modification, and development of Moreno and Jennings' proposals are presented in Section IV of this paper.

---

[4] An investigation which follows the same individuals through several years of common participation in a group is provided in Jennings' "Structure of Leadership—Development and Sphere of Influence." *Sociometry,* I: 99-143, July-October, 1937. Jennings' *Leadership and Isolation* (New York: Longmans, Green and Co., 1943), is likewise based on a comparison of structure at different time points in the same community.

IV. THE MATHEMATICAL PROBLEM PRESENTED BY DIVERSE SOCIOMETRIC SITUATIONS

1. *The Inapplicability of Conventional Concepts and Methods*

In ordinary sociometric situations where the number of choices in circulation varies from time to time and from group to group the estimating of status, coherence, and cleavage on the basis of the number of choices received or of elements observed is misleading. On the other hand, it is obvious that any valid index which can be developed must be a function of the number of choices and elements. In the present paper various methods of treating sociometric scores are critically examined to determine the characteristics requisite for an acceptable index.

The Limitations of Rank, Quartile, and Percentile Methods. While an index based on rank is admissible and useful for expressing status of a variable within a particular distribution, it is hardly adequate for the comparison of status in distributions of varying content and range. This is evident, inasmuch as the rank corresponding to a particular score (and consequently its percentile or quartile position) is determined not only by the numerical score value but also by the range and distribution of all other scores in the series. Consequently the significance of a rank-determined index varies from distribution to distribution. Lindquist (39:32, 119) and Garrett (36:184) present this argument in greater detail.

To take a specific sociometric example the individual in the fourth or bottom quarter of a large well-knit group wherein all participants have received several choices may be much better off than a person in the third quarter of a small, poorly integrated group composed of many isolates and exclusive cliques.

Inadequacies of Ratio Methods. Moreno (13:98-103) and Zeleny (29, 30) have proposed various proportion-indices for the measurement of social status. The general procedure adopted in all these measures is that of determining the ratio of the number of choices involved in a particular sociometric phenomenon to the total number of choices available.

Such devices are subject to much the same criticisms as were applicable to rank-determined methods, for the percentile, quartile, and the like, are themselves ratio concepts. Consequently, as Dubin (4) indicates and Zeleny (31) himself concedes, such indices as Zeleny's "social-status ratio" and "social-status score" (30) are not fully adequate both from the point of view of mathematical equivalence and clinical value.

Inadequacies of Standard Units as Conventionally Utilized. In applied statistics the pitfalls of the rank or percentile method may frequently be avoided by the use of the standard measure of z-score (39:129; 44:80). In the present instance, however, the standard score is subject to much the same limitations as the percentile. Being a function of the standard deviation, it is likewise affected by the range of scores within the group. In ordinary practice, this difficulty is surmounted by estimating the population variance (44:69-71) or by actually computing the variance for a large standardization group. In a sociometric setting, neither of these procedures may be utilized. Increasing the size of the sample has the anomalous effect, by introducing more potential choosers and chosen, of altering the number and size of units in the measuring stick.

Moreover, as Moreno and Jennings indicate (21:343), the sociometric situation has many characteristics of the *Gestalt*. "One part of the structure is interdependent with another part; a change in position in one individual may affect the whole structure." The converse of this statement is obviously equally true; a change in the structural pattern will alter the status of the individual. Consequently, in sociometry it is impossible to resort to the practice common in psychological measurement of evaluating individual status *as such* without particular concern for a specific psychological setting. Moreno stresses this point (13:80):

> . . . [in] psychometric classification methods which measure an individual's intelligence, aptitude, and abilities . . . the attitude of classification is centered upon *one* individual singly, whereas the individuals and groups around him are only summarily considered. In contrast, we do not deal with an individual separated from the sociodynamic situation in which he lives. . . .

Each sociometric setting, then, may be regarded as representing a unique organizational entity. When one passes either by inference or experiment into a larger social group, the effect is not that of moving up the scale, but of passing from one frame of reference to another. Consequently, neither the a priori nor a posteriori methods of statistical projection may be applied for the solution of the present problem.

The Suitability of Indices Considered as Measures of Statistical Significance. While several of the mathematical devices discussed above may be evaluated for statistical significance, such evaluations are somewhat gratuitous inasmuch as the significance of the index itself has been shown to vary from setting to setting. Before data on the statistical significance of sociometric results may be interpreted meaningfully, a generally-applicable index of status must be devised.

The Necessity for a Constant Frame of Reference. The most common statistical devices for expressing and comparing status have been examined and found not fully adequate for sociometric needs. The character of the inadequacies suggests, in turn, the requisites of an acceptable index. Comparison implies a criterion. For comparison to be valid this criterion must remain constant. The methods discussed thus far have been unsatisfactory largely because the criterion proposed was itself a function of the variables to be compared. The problem, then, is to develop an *absolute* criterion—a frame of reference against which the various phenomena of sociometric choice may be projected but which is itself independent of these phenomena. A criterion of this type is suggested and developed in the succeeding sections.

2. *The Concept of Deviation from Chance Expectancy*

For purpose of vividness the question of statistical significance may be phrased in the following terms: "To what extent is the distribution of choices obtained in a sociometric test at all different from that which would be secured by having blindfolded subjects draw names from a hat?"

"Draw names from a hat" is equivalent to saying, "Let all choices be determined by chance." How do the *conditions* of such a chance situation differ from those of the sociometric test? It is obvious that mathematically the settings can be quite equivalent: the number of persons participating, the number of choices made by each person, the order of selection—all these may be made identical. Indeed, even the resulting choice patterns may turn out to be similar in configuration and number. But even should this occur, there would still be one fundamental difference between the two situations; for in the one, results cannot be affected by attractions and repulsions between persons in the group, while in the other these factors may be and probably are operative. Consequently, any *marked* difference between the structure and frequency of choice-patterns within the two settings cannot be attributed to variation in size of sample, number of choices in circulation, or other mathematical factors, but must be explained largely in terms of the presence or absence of what may best be called *social forces.*

The Concept of Chance Expectancy Applied. For each sociometric setting, then, one may take the analogous chance situation as a mathematically pure case, an archetype unsullied by human preference or prejudice. By comparing the results obtained in the true sociometric setting with those secured under conditions of chance, sociometric phenomena may be identified and described in terms of the deviation from chance expectancy induced by the social forces operative in the structure.

At the same time such a procedure takes into account the effect produced by variation in the size of the group, the number of criteria, and the total number of choices in circulation. The relative ease or difficulty with which various elements may appear in diverse sociometric situations is automatically considered.

Specific Illustrations. The significance of the procedure suggested above can best be clarified by citing several examples. Thus, if in a given sociometric situation an individual is selected 15 times, and if the likelihood of his being chosen this many times by chance alone is .01, the latter figure may be used to describe his social status and to compare it with that of another person, chosen the same number of times—but in a different setting where the likelihood of receiving 15 choices by chance may be as great as .40. It is evident that the former individual is far closer to being a *star* than the latter, since he is selected in excess of chance to a far greater degree than his colleague in the second situation.

Similarly, if in a particular sociometric setting, seven mutual choices appear and if the probability of this many choices occurring by chance is .05, as against an index of .60 for another social group, the former figure may be interpreted legitimately as indicating a greater degree of mutual acceptance in the former of the two groups.

The same procedure may be applied to other quantitatively significant elements and characteristics of sociometric groups.

Chance Expectancy as an Index of Statistical Significance. It will be evident from the very nature of the deviation-from-expectancy concept that it not only provides a constant frame of reference but that it may at the same time serve as an index of statistical significance. The conventional application of the null hypothesis (38-II:117-118) involves the transformation of some type of standard unit into an area equivalent. If this area—or rather, its corresponding probability—is sufficiently small to preclude the explanation of obtained results on the basis of chance, the data secured are adjudged statistically significant. It will be noted that in the procedure outlined in the preceding section results are already expressed in terms of chance likelihood of occurrence; no transformation of units is necessary. Where the probabilities for a particular sociometric pattern are sufficiently extreme to require an explanation other than chance, the pattern may be regarded as statistically significant. The person in the first of the two sociometric situations cited above received as many choices as could have been obtained by chance only one time out of a hundred on the average. This probability is too small to admit of any reasonable contention that the chance event actually occurred. Consequently, there is adequate basis to conclude that factors other than fortuitous circumstances have contributed to the relatively high score. Similarly the number of mutual ties corresponding to a probability of .05 is sufficiently large to be considered statistically significant. In contrast, the obtained indices of .40 and .60 are not extreme enough to establish or exclude any hypothesis.

As Yule and Kendall indicate (50:424-25), levels of significance are of course adopted toward the extreme of the distribution at arbitrary points. The most generally accepted limits are the 1 per cent and 5 per cent values (38-II:117).

Contributions of Moreno and Jennings. While the application of the concept of chance expectancy to sociometric data was developed independently by the writer, examination of the literature reveals that Moreno and Jennings (21) also have suggested the utilization of this principle and have applied it to a limited extent in comparisons between chance-determined choice patterns and those secured in actual sociometric settings.

While the Moreno and Jennings article is highly suggestive, it contains no clear or systematic development of the implications and applications of the chance-expectancy concept. For example, the notion of statistical significance, though implicit in the discussion (21:352-56), is not stated outright, nor is the question of level of significance considered.

Similarly, while the necessity and basis for more rigorous methods of treating sociometric data are realized, practical devices and their interpretation are not indicated. Thus Moreno and Jennings see clearly the need for a constant frame of reference and suggest utilization of the chance-concept as an appropriate solution (21:349):

> Study of the findings of sociometric tests showed that the resulting configurations, in order to be compared with one another, were in need of some common reference base from which to measure the deviations. It appeared that the most logical ground for establishing such a reference could be secured by ascertaining the characteristics of typical configurations produced in chance balloting for a similar size population with a like number of choices.

However, the actual development and employment of status-indices such as those proposed in this paper are not attempted.

In summary, while the use of the chance distribution as a common reference base has been supported by Moreno and Jennings, their exposition is exploratory and suggestive rather than definitive and functional. Viewed in terms of application, the concept of chance expectancy furnishes a basis for developing a doubly effective technique, for "killing two birds with one stone." On the one hand, it permits identification of statistically significant results. On the other hand, the concept provides a constant frame of reference against which data from diverse sociometric situations may be projected without distortion. As a result indices for the evaluation and comparison of status and structure may be developed.

Such indices require the computation of probabilities of occurrence for various sociometric events. The problem posed by such computation is treated in the next section.

V. COMPUTATION OF PROBABILITIES

1. *The Nature of the Problem*

In general, the problem of computation required for deriving status indices based on chance expectancy may be phrased as follows: What is the probability that the various phenomena of choice will occur one or more times in a situation where chance alone is operative? To take a specific example, what is the likelihood that a particular person will be chosen once, twice, three times, etc., merely by chance?

Moreno and Jennings' Treatment. Faced by this same problem, Moreno and Jennings (21:347-49) resorted principally to the direct method by determining chance patterns empirically. Ballots with names of all participants were drawn from a "shuffling apparatus" and the configurations obtained were compared to the results of actual sociometric tests for populations of similar size and like number of choices.

While it has the advantages of mathematical simplicity and vividness, the empirical approach is hardly an economical one. In effect, it necessitates doubling the amount of tabulation and analysis. For every sociometric situation, there is an analogous chance distribution to be examined, resolved into elements, and evaluated. Moreover, since chance distributions are themselves subject to random variation, the representativeness of any one sample is always questionable. The sample itself may deviate markedly from chance expectancy, purely by *chance*.

This difficulty was realized by Moreno and Jennings. In an attempt to insure the validity of the chance frame of reference, they computed averages for the number of various elements observed in *seven* experiments carried on under mathematically identical random conditions. To adopt such a procedure for general use is obviously highly impractical.

Finally, as an additional check on the representativeness of the sample, Moreno and Jennings approached the problem deductively by seeking the *expected value* (38-II:99),—the theoretically-derived probability that a particular event will occur.

The mathematical aspects of the problem were referred to Lazarsfeld

(21:349-51, footnote). Lazarsfeld showed that in a group of N subjects where each subject is allotted d choices, p, the probability that a given individual will be selected by any other individual, is given by the formula:

$$p = \frac{d}{N - 1} \tag{i}$$

The denominator is $(N - 1)$ and not (N) because the individual is not permitted to choose himself.

Utilizing the conventional symbols, the probability of not being chosen $(1 - p)$ is denoted by q. Larzarsfeld then applies the classic principle of Bernoulli (32), cited by Fisher (35:65) that

> . . . if the probability of an event occurring were p, and the probability of it not occurring were q $(= 1 - p)$, then if a random sample of n trials were taken, the frequencies with which the even occurred 0, 1, 2, . . . , n times were given by the expansion of the binominal $(q + p)^n$

Thus the likelihood of an individual's being chosen once, twice, three times, etc., may be obtained from successive terms of the expansion of $(q + p)^n$ where $n = N - 1$.

In like manner, Larzarsfeld presents an expression for determining the probability (p_m) that a mutual choice will occur by chance

$$p_m = p^2 \tag{ii}$$

The probability (u_p) that an unreciprocated choice will occur by chance is not given directly by Lazarsfeld, but it may be derived from the value (U) which he uses to determine "the probable frequency of unreciprocated choices."

$$U = N(N - 1)pq \tag{iii}$$

Since the total possible number of combinations of N things taken two at a time is $\frac{N(N-1)}{2}$, the probability that one unreciprocated choice will occur is given by the expression

$$u_p = N(N - 1)pq \cdot \frac{2}{N(N-1)} = 2\,pq. \tag{iv}$$

The probability that either of these phenomena (mutual or unreciprocated choice) will occur a given number of times is again obtained by expansion of the binomial.

While Lazarsfeld indicates that, by extension of the method cited, probabilities for more complex choice patterns may be computed, the actual derivation of formulae is not attempted. Thus the groundwork for developing indices for degree of isolation and cleavage is yet to be accomplished. A portion of this work is essayed by the writer in Part III of this paper.

However, the most serious limitation of Larzarsfeld's technique is still one of computation. An attempt to apply the method as developed reveals that the sheer task of calçulation is too complex to make extensive application feasible. Unless the exponent is very small, utilizing Lazarsfeld's procedure of evaluating each term of the binomial expansion becomes a tedious and troublesome process incompatible with requirements exacted by available time and energy. Furthermore, because of the number and range of variables, construction of tables for the expanded binomial has been impractical.

It is evident, then, that unless practicable methods for determining probabilities are devised, the proposed solution of the problem of status index remains in effect a theoretical one. To overcome the difficulty, the present writer suggests the utilization of mathematical techniques for *approximating* the sum of the terms of the binomial expansion. Several such methods have been developed. They will be examined critically in the following section.

2. *Methods for Approximation of the Expanded Binomial*

This section presents a survey of mathematical techniques for approximating the terms of the binomial or Bernoulli series. The methods will be considered roughly in the order of their chronological development.

Approximation by Stirling's Formula. The general term of the Bernoulli series may be written in the form ${}_nC_x q^{n-x} p^x$, or more explicitly $\frac{n!}{x!(n-x)!} q^{n-x} p^x$.[5] One of the chief difficulties in evaluating the expression arises from the presence of factorial terms. An early solution to this problem was that offered by Stirling (1730), who developed an approximation formula for $n!$ (46:9).

$$n! = (\sqrt{2\pi n})(n^n)(e^{-n}) \qquad \text{(v)}$$

As Carver indicates (49:252) this formula may be applied to the factorials in the general term of the binomial and the numerical value of the expansion thus determined.

Limitations of Stirling's Approximation. Though it does permit the evaluation of factorial terms without extensive computation, Stirling's approximation method has several distinct disadvantages. It demands the understanding and manipulation of rather advanced mathematical concepts. It requires the use of seven-place tables of $\log_{10}(n!)$ which are available only in specialized and ponderous compilations (37:98; 42:482). Finally, as emphasized in standard works (46:9; 50:178), the approximation is valid only for large values of n. Since in sociometric situations the use of one criterion is common in groups of less than twenty or thirty, the exponent, n, will frequently not be large enough to warrant the use of Stirling's formula and yet be too large to permit of the treatment by straightforward computation. Consequently, Stirling's approximation is of limited practical value.

---

[5] C is the conventional operational symbol for combinations; the expression ${}_nC_x$ is read "the combination of n things taken x at a time." The expression $n!$ denotes the factorial series $n(n-1)(n-3) \ldots 3 \cdot 2 \cdot 1$.

Approximation by the Normal Probability Curve. The most common and frequently the only method for evaluating the binomial cited in standard works on mathematical statistics is approximation by reference to the normal probability curve. Principles and methods involved in the approximation are adequately described by Camp (34:209-216) and Kenney (38-II:19-23). Tables of areas and ordinates for the normal curve are too common to require specific reference.

Limitations of Approximation by the Normal Curve. While the normal curve is subject to well-recognized restrictions in treatment, current practice would lead one to assume that it was sufficient only to state the limitations and then to proceed however one pleases. Nevertheless, as is stressed by more careful workers the normal curve is a "good fit" only "for point binomials in which n is large, and p is nearly equal to q" (34:210). As will be evident below, this implies that the skewness of the distribution must be approximately zero, and that the range in either direction from the mean is not extreme.

These restrictions have imposed serious handicaps in routine statistical work. This fact was recognized as early as 1895 by Pearson who, in his definitive memoir of that year (40:360), emphasized the point that "to deal effectively with statistics we require generalized probability curves which include the factors of skewness and range."

With particular reference to sociometric applications, it has already been stated that n may frequently be small. Furthermore, for p to be "nearly equal to q" would require rather peculiar and unrealistic conditions. Since $p = \frac{d}{N-1}$ (Equation i) and $q = 1 - p$, writing the requisite equally results in

$$\frac{d}{N-1} = 1 - \frac{d}{N-1} \qquad \text{(vi)}$$

Solving this expression for d yields

$$d = \frac{N-1}{2} \qquad \text{(vii)}$$

Thus for the equality to be satisfied, the number of choices (d) allotted each person must be equal to or greater than almost half the number of persons in the group. Since the largest number of choices per person generally accorded in sociometric work is five, a situation wherein p would be approximately equal to q is hardly likely to occur in practice.

Since the skewness of a binomial distribution is given by the expression $\frac{q-p}{\sqrt{npq}}$, (38:II-14) it follows that in the general sociometric setting where q is considerably greater than p, the resulting considerations, the normal probability curve is inadequate for approximating the binomial as it appears in most sociometric situations.

Approximation by the Poisson Distribution. In 1837, Poisson (45) published the distribution of the function:

$$f(x) = \frac{m^x e^{-m}}{x!} \qquad \text{(viii)}$$

where $m = np$ and e is the base of Napierian logarithms. This expression, known as Poisson's distribution or Poisson's exponential limit, may be used to approximate the binomial under the specific conditions when "n is large and np is in the neighborhood where x is small" (38:II:30). The function has been tabulated by Pearson (42:113-24) and the mechanics of application are described and illustrated by Yule and Kendall (50:190).

Limitations of the Poisson Approximation. As has been stated, the exponential function offers a valid estimate of the general term of the binomial only when p or q is very small (usually less than .05) and n is fairly larger (greater than 12 or 15). While these conditions are often satisfied in sociometric situations, this is hardly the general rule. Moreover, the published tables of the Poisson distribution give cell values rather than cumulative frequencies. Thus in order to determine the probability of an event occurring as many as fifteen times, it is necessary to determine the probability of its occurring once, twice, three times, etc., and then summing the several probabilities. In summary, only when the conditions producing the distribution are satisfied and merely the first few terms of the expansion are desired, does the Poisson function give a quick and accurate estimate.

Approximation by Means of the Incomplete Beta Function. All the methods commonly presented in the better statistical works have now been discussed. While one or the other procedure may be applicable in a particular situation it is evident that none represents a generally effective device for approximating the expanded binomial. The situation has been well summarized by Camp (33:163):

> It is known that the normal curve, as fitted to the point binomial . . . is not a good enough fit to give this [the probability] integral very accurately even where n is large, except near the mode, especially when the binomial has even a moderate degree of skewness. When n is small, the individual terms may of course be computed and added together, and when the probability of successes is very small and n large, the Poisson series is available, but in the remaining cases there is no good method.

To remedy this situation, Camp proposed two more generally useful schemes for evaluating the Bernoulli function. One of these involves utilization of the Incomplete Beta Function (38-II:41):

$$B_x(m,n) = \int_0^x x^{m-1}(1-x)^{n-1}dx. \qquad \text{(ix)}$$

The approximation, yielding rather accurate results, is based on the "unpublished theorem" of Pearson "that the sum of the first p terms of a binomial is expressible in terms of the Incomplete Beta Function" (33:171).

The development and application of this theorem are presented in detail by Camp (33:167-71).

The evaluation of the Incomplete Beta Function requires a knowledge of mathematical theory and skill possessed only by the trained mathematician. Recently, however, Pearson (43) has completed the monumental work of tabulating the function so that values may be read directly. The table has three arguments: x, which corresponds to q in the notation of this paper; q, which corresponds to the rth term of the expansion; and p, which corresponds to $(n + 1 - r)$, where $n + 1$ is the total number of terms in the expansion. By reference to these tables it is possible, without any computation whatever, to find accurately the sum of terms of the Bernoulli series.

Limitations of the Incomplete Beta Function. Pearson's tables are bulky, expensive and not generally available. Moreover they are tabulated only for $n < 50$, and this renders them useless in many sociometric situations where groups are large or where more than one criterion is used. The latter practice has the effect (see page 21) of doubling, tripling, etc., the population size. Consequently, exponents larger than 50 are common.

Approximation by the Gram Charlier Series. As indicated by Kenney (38-11:59), the Gram-Charlier series may be utilized generally for purposes of approximation:

> If a function $f(x)$ gives only a rough approximation to a frequency distribution, a more accurate representation may be obtained by using the first few terms of the series
>
> $$F(x) = c_0 f(x) + c_1 f^{(1)}(x) + c_2 f^{(2)}(x) + \ldots + c_n f^{(n)}(x) + \ldots \qquad (x)$$
>
> where $f(x)$, called the "generating function," gives a first approximation to

the given distribution and $f(x)$ is the nth derivative of $f^{(n)}x$ with respect to x.

This principle is applied by Camp (33:163-65) for approximating the Bernoulli series. It is further developed and supplemented by appropriate tables in Camp's textbook (34:216-21, 373-95). Binomial distributions are classified under four types (34:377) in accordance with the relative size of the several parameters; for each type, a specific rule and table, or combination of these, apply.

Limitations of the Gram-Charlier Series. As may be suggested by the preceding paragraph, the application of the methods developed by Camp is sometimes rather confusing and complex. Moreover, though the procedures were designed to supplement the more limited conventional techniques, Camp himself states that they are "safe to use" when the limits of the expansion to be evaluated "are not very far from the mean and p is not very different from q" (34:218). It is evident then that the Gram-Charlier approximation is likewise qualified in scope and practical usefulness.

Approximation by the Type III Function. An approach hardly mentioned in the standard works is that of Carver, who developed "a method which will enable us to find approximately the value of any term of the expansion $(p+q)^n$ and the sum of any number of consecutive terms of this series" (49:252).

Proceeding from the principle that the mean, standard deviation, and skewness "may be regarded as satisfactorily describing any distribution" (49:252), Carver proposes that:

> A tabulation of Pearson's Type III Curves for various degrees of skewness affords . . . the most satisfactory representation of frequency distributions from the point of view of both effectiveness and facility in using (49:233).

Having derived the three elementary functions for Bernoulli's series (49:252-56):

$$M = np \tag{xi}$$

$$\sigma = \sqrt{npq} \tag{xii}$$

$$a_3 = \frac{q-p}{\sqrt{npq}} \tag{xiii}$$

Carver applies these for approximating the area under the Type III curve for a particular abscissal value by expressing that value in terms of standard units and reading from appropriate tables the corresponding area under the curve. Several specific applications are cited in detail (49:236-42), 257-59).

Kenney (11:50) demonstrates that by proper substitution, areas for the Type III curve may be evaluated by means of the Incomplete Gamma Function:

$$\Gamma_x(n+1)=\int_0^x e^{-x}x^n\,dx \tag{xiv}$$

This function has been tabulated by Pearson (41). More recently, however, tables of Type III areas and ordinates have been prepared by Salvosa (47). Since these require only conversion into standard units, they are much more suitable for practical use. The tables are available in handbook form (48).

Limitations of the Type III Curve. Though Carver mentions no restrictions regarding the applicability of the Type III curve as an estimate of the binomial, it is obvious that approximation will not be valid when n is very small. Nevertheless as indicated below, fairly accurate estimates may be made even when the exponent is below 20. The chief limitation of the technique is the necessity of computing the theoretical mean, standard deviation, and skewness for each sociometric setting and finding the standard unit equivalent for each term of the expanded series. However, with the aid of a calculator, this can be accomplished in a few minutes.

Comparison and Summary. From the point of view of mathematical simplicity and practical convenience, but three of the alternative methods presented in this chapter merit consideration as effective techniques for approximating the binomial expressions which occur in sociometric situations. The three procedures are those utilizing the Poisson Exponential, the Incomplete Beta Function, and the Type III Curve.

Of the three, the Poisson function is rather limited in scope but is most easily applied. Approximation by the Incomplete Beta Function yields the most accurate results, particularly for small values of n. However, tables are not available for $N > 50$. The Type III Function, while it involves a little more computation, is the most generally applicable. It yields excellent approximations for large values of n and acceptable results for values of n below 20.

An illustration of the relative accuracy of results is presented in Tables 1 and 2 (since such conditions present the greatest difficulty for accurate approximation examples are deliberately selected with n small and p and q neither alike nor widely divergent). Table 1 shows actual computed values for the expansion of $(.88 + .12)^{25}$, as compared with estimates for the sum of terms made from the Incomplete Beta Function, the Type III Curve, and the Poisson Exponential. It will be noted that though p is as high as .12, even the Poisson yields acceptable results. Table 2 presents an ex-

LIBRARY

TABLE 1

COMPUTED AND APPROXIMATED VALUES FOR THE SUM OF THE FIRST ONE TO TEN TERMS OF THE EXPANDED BINOMIAL $(.88 + .12)^{25}$

	Sum of Terms			
		Approximated Value		
Number of Term	Computed Value	Beta Function	Type III Curve	Poisson Exponential
1	.0409	.0409	.0434	.0497
2	.1804	.1804	.1765	.1990
3	.4085	.4088	.4073	.4230
4	.6468	.6475	.6500	.6470
5	.8255	.8265	.8285	.8150
6	.9278	.9291	.9277	.9158
7	.9743	.9757	.9739	.9662
8	.9915	.9929	.9916	.9878
9	.9968	.9982	.9975	.9959
10	.9982	.9996	.9994	.9986

TABLE 2

COMPUTED AND APPROXIMATED VALUES FOR THE SUM OF THE FIRST ONE TO NINE TERMS OF THE EXPANDED BINOMINAL $(.7 + .3)^{10}$

	Sum of Terms			
		Approximated Value		
Number of Term	Computed Value	Beta Function	Type III Curve	Poisson Exponential
1	.0282	.0282	.0245	.0498
2	.1493	.1493	.1321	.1992
3	.3827	.3828	.3563	.4232
4	.6495	.6496	.6742	.6472
5	.8496	.8497	.8630	.8152
6	.9525	.9637	.9554	.9160
7	.9893	.9905	.9885	.9664
8	.9980	.9984	.9976	.9880
9	.9994	.9999	.9995	.9961

treme case, the expansion of $(.7 + .3)^{10}$, which would ordinarily be evaluated only by direct computation. The example is cited to indicate how accurately probabilities may be approximated even when n is exceedingly small; only the results obtained from the Poisson Exponential are so divergent as to be practically valueless.

In view of the considerations outlined above, approximation by reference to the Type III Curve is recommended as the best single procedure to be adopted for general use in sociometric situations.

3. *The Determination of "p" and "n" for Major Sociometric Events*

The procedure outlined in Section 1 for developing indices of sociometric status involves the expansion in a binomial series of $(p + q)^n$ where p is the chance probability of a particular sociometric event and n is the total possible number of times the event may occur. Techniques for carrying out this expansion efficiently were presented in the preceding chapter. It is evident, however, that before these techniques may be applied it is necessary to determine the value of p and n for the major sociometric elements.

While Lazarsfeld has made a beginning in the derivation of the requisite expressions, as was indicated in Section 1, a more detailed and extensive development is required. The initial steps of such a development are essayed below.

The Probability of Selection. The probability (p) that a particular individual will be selected by any other individual was given by Lazarsfeld (21:350) and was cited in Equation i:

$$p = \frac{d}{N-1} \, .$$

Since a person can be chosen by everyone in the group except himself, the binomial exponent corresponding to p is $(N-1)$.

Equation i is applicable in any sociometric situation provided only one criterion is used. It has become practice among such investigators as Northway (33, 24) to seek a more general estimate of social status by utilizing several criteria simultaneously; that is, each subject is asked to select associates for several different activities and is permitted to choose the same person for more than one activity. Under such conditions, Equation i is no longer valid. Moreover, it becomes necessary to define the unit of social acceptance more rigidly, for the number of choices received is no longer identical with the number of different persons choosing. If the sheer number of choices, regardless of whether they come from a few or from many persons, is considered as the indicator of status, the probability of occurrence remains $\frac{d}{N-1}$, inasmuch as an individual can choose another person only once on the basis of each criterion. However, the total number of choices available is increased and becomes a direct multiple of the number of criteria.[6] For example if three criteria are being utilized, the exponent of the binomial becomes $3(N-1)$.

On the other hand, one may choose to consider as the more valid indicator of social status not the number of choices received but the number of *different persons* by whom an individual is chosen, or, to put it another

---

[6] Thus increasing the number of criteria has the effect of increasing the size of the group, a circumstance which permits effective analysis even in groups of as few as nine or ten persons.

S.C.E.R.T., West Bengal
Date.......................
Accession No. 866
S.C.E.R.T., West Bengal Library

way, the number of different ballots upon which an individual's name appears at least once. If such be the case, the exponent remains $N-1$ regardless of the number of criteria, but the required probability (p_c) is no longer $\frac{d}{N-1}$ but may be shown to be:[7]

$$P_c = 1-(1-p)^c = 1-q^c \qquad \text{(xv)}$$

where c is the number of criteria and $p = \frac{d}{N-1}$.

The question of which type of unit is the more sensitive indicator of social status can be answered only after clinical experience and experimental study.

Probability of Mutual Selection. Lazarsfeld's solution for the probability of a mutual choice has already been cited (Equation ii):

$$P_m = p^2.$$

The question remains as to what is the proper value for the binomial exponent; that is, what is the maximum number of mutual choices which may occur. The value is not $(N-1)$, for this represents the maximum number of mutual ties in which a *single person* may be involved—not the grand total for the group. The required exponent is obtained by determining the number of ways in which N things may be taken two at a time without regard to order. Expressed mathematically

$${}_NC_2 = \frac{N(N-1)}{2}.$$

The utilization of several criteria simultaneously necessitates modifications analogous to those presented in the previous section, though in some instances the development of formulas becomes considerably more complex. A more precise definition of the mutual element is of course required. If reciprocated choices are recognized only when they are based on one and the same criterion, the only alteration is in the size of the exponent, which again becomes a multiple of the number of criteria. If, on the other hand, relationships *between* as well as *within* criteria are recognized, several combinations are possible for each of which separate probabilities may be calculated. For example, the probability that any two *persons* will choose each other, regardless of whether they do so once or several times or whether on the basis of the same or different criteria, is given by the expression[8]

---

[7] The probability of not being chosen (q) remains constant whether one is counting choices or ballots. In c sociometric situations (one for each criterion) the probability of *not being chosen is* q^c. It follows that the probability of *being chosen* is $1-q^c$.

$$P_{mc} = (1 - q^c)^2 = p_c^2 \,. \qquad \text{(xvii)}$$

The corresponding exponent is again given by ${}_NC_2 = \frac{N(N-1)}{2}$.

The Probability of Unreciprocated Selection. Since the presence of an unreciprocated choice may be interpreted as an indication of poor group coherence, Moreno and Jennings have been concerned with the frequency of this pattern and Lazarsfeld has treated it in his development of probabilities of chance occurrence. However, as will be shown below, such concern is generally gratuitous inasmuch as the unreciprocated choice cannot be regarded as an independent variable if the mutual choices are also regarded as such; that is, given a particular sociometric situation with a stated number of mutual ties present, the number of unreciprocated choices is automatically fixed.

This may be shown mathematically as follows:

Given N, d, and M where N is the number of subjects, d the number of choices, and M the total number of mutual ties obtained, the total number of choices in circulation (Nd) may be denoted by the constant T. All choices are either reciprocated or unreciprocated. Each mutual pair involves two choices; each unreciprocated pair, one choice. Therefore

$$T = 2M + U \qquad \text{(xviii)}$$

where U is the number of unreciprocated choices. Solving for U:

$$U = T + 2M \,. \qquad \text{(xix)}$$

Since all the terms on the right side of the equation are constants, U is fixed. In the terminology of mathematical statistics (50:415), there are no degrees of freedom.

There are conditions, however, when the number of unreciprocated choices is not fully determined by the number of mutuals. This occurs when several criteria are utilized simultaneously and mutual or unreciprocated patterns are not restricted to the same criterion. For example, if an unreciprocated choice is defined as a combination of two *persons* (rather than choices) one of whom chooses the other at least once but is not chosen at all in return, the probability of chance occurrence (p_{uc}) is given by

$$p_{uc} = 2q^c(1 - q^c). \qquad \text{(xx)}$$

Since "an unreciprocated choice of A by B is counted separately from an unreciprocated choice of B by A" (21:351), the corresponding exponent will be:

---

[8] As is suggested by the formula, the proof of this relationship is analogous to that for p_m and follows directly from Equation xv.

$$2\,{}_NC_2 = N(N-1). \tag{xxi}$$

For multi-criteria situations, other definitions of unreciprocated and mutual choice than those discussed in this paper are possible. Appropriate p's and n's may be derived by deductive methods analogous to those employed above.

Probability of Inter-Class Choice. Since an expression for the chance probability of choice between sexes or other dichotomous groups was not developed by Lazarsfeld even in rudimentary form, it was necessary to undertake the complete derivation. The result is presented in Equation xxii.

$$P_{a-b} = \frac{{}_bC_1 \cdot {}_{a-1}C_{d-1} + 2\,{}_bC_2 \cdot {}_{a-1}C_{d-2} + 3\,{}_bC_3 \cdot {}_{a-1}C_{d-3} + \cdots + d \cdot {}_aC_d}{d \cdot {}_{n-1}C_d} \tag{xxii}$$

where N is the number of subjects, d the number of choices allotted to each, C the operational symbol for combination, a and b the number of persons in each of two dichotomous classes, and P_{a-b} the probability that a person in class a will choose another in class b. By performing the indicated operations, this expression may be reduced to the simple form

$$P_{a-b} = \frac{b}{N-1}. \tag{xxiii}$$

The maximum number of times an interclass choice of this type may occur is given by the product (ad). To determine the probability that b will choose a, the terms in Equation xxiii are merely interchanged.

$$p_{b-a} = \frac{a}{N-1}. \tag{xxiv}$$

The most common applications of the two-class formula are in the study of sex or race relationships. The expression may of course be applied to any dichotomy whatever. When several criteria are utilized simultaneously, adjustments analogous to those presented in preceding sections are required.

With regard to the methods of deriving Equations xxii, xxiii, xxiv, and other formulas presented by the writer, two approaches were used: The probability was first developed deductively utilizing the ratios between combinations. The results were then checked empirically by analysis of small scale problems. For example, after the equations for inter-sex choice were established, they were applied to a theoretical group of three girls and four boys, each of whom were allotted two choices. All the possible combinations were then written out and a count made of those which contained a choice of a boy by a girl. The ratio of this sum to the total possible number of combinations was determined and checked against the a priori result. If both methods are applied without error, the computed ratio is of course identical with the deduced probability.

Equations xxii, xxiii, and xxiv are valid only for dichotomous groups. Analogous expressions may be developed for the probability of inter-class choice when there are more than two categories. Thus it is possible to derive indices for the study of relationships between sub-groups differing in age, nationality, mental status, etc. The constancy and coherence of cliques may be investigated in similar fashion. Because of the great variation in structure of social groups and the manifold problems to which indices of cleavage may be applied, it is impractical to attempt to develop appropriate formulas in advance. These may be derived more adequately and expressed in more convenient form when the specific conditions of the sociometric situation are known.

Probability of Isolation. The number of isolates occurring in a sociometric setting has been regarded by Moreno as an additional indicator of the degree of social coherence within the group. Though comparison between frequencies of isolates in chance and sociometric situations is made by Moreno and Jennings (21:354), Lazarsfeld makes no attempt to derive the theoretical probability of occurrence for this event. It is evident, however, that since the likelihood of *being chosen* is $\frac{d}{N-1}$ the probability of *not being chosen* is clearly $1 - p$ or q. Unfortunately, though, one cannot proceed as before to determine the probability of one, two, three, or more isolates by expanding the binomial $(q + p)^{N-1}$, for it will be recalled that this expansion does not give the probability of isolation but of selection; the successive terms of the expansion represent the likelihood that a person will be chosen 0, 1, 2, 3 . . . $(N + 1)$ times. Consequently, the probability of a given number of isolates cannot be obtained from a Bernoulli series but must be evaluated from an appropriately derived expression. This expression, developed deductively and checked by empirical methods as described above, is presented in Equation xxv.

$$P_i = 1 - \frac{(N-i-2)(N-i-3)\ldots(N-i-d-1)}{(N-1)(N-2)\ldots(N-d)} \quad \text{(xxv)}$$

where P_i is the probability that i *or less* isolates will occur by chance; N and d retain their customary significance.

It will be noted that the above formula may be applied directly without resort to transformation or to tabulated values.

Unlike other elements the isolate does not require more rigorous definition in situations where more than one criteria is utilized. For the term to retain its literal significance, the isolate must remain completely separated from the rest of the structure regardless of the complexity of that structure.

However, Equation xxv applies only when one criterion is used. If several are utilized, the probability that a given number of isolates will occur by chance is given by the expression $(P_i)^c$, where c is the number of criteria.

Summary. Expressions and techniques for determining the probability of occurrence for the major sociometric events have been developed. The application of these in specific sociometric situations will be illustrated in the succeeding section.

VI. ILLUSTRATION OF METHOD

To provide a concrete illustration, the above techniques will now be applied to data from a specific sociometric situation; indices of status, coherence, and cleavage will be computed.

Constitution of Group. The group for which results are to be analyzed is a third-grade class composed of sixteen children—four girls and twelve boys. Since the purpose is to demonstrate technique only, further description is not necessary.

Content of Sociometric Test. The sociometric test utilized was one of the composite type involving three criteria. Each child was asked to select *two* children as associates for each of the following situations: sitting together, doing school work together and going to the movies together. The criteria were presented in questionnaire form.

Tabulation of Results. A convenient form for tabulating results is illustrated in Table 3. Children are identified by the number at the head of each row and column. All the choices made by a particular child are recorded in the row opposite his number. For example, Child 1 chose the following children: 2, 3, 11, 13, and 16. Within each cell or box, the choices for the several criteria are presented separately from left to right in the sequence: luncheon preference, school work preference, movie preference; the number indicates the level of the choice (first or second). For example, Child 1 selected Child 2 as first choice for luncheon companion and Child 3 as second choice. For work associate his preference was Child 11; his second preference was again Child 2. As first choice for movie companion he selected Child 16; as second choice, Child 13.[9]

By glancing down each column of Table 3, it is possible to identify all choices a child has received as well as the basis and level of each choice. Child 1, for example, received first choices from Child 2 and Child 8; sec-

---

[9] The zeros appearing in Table 3 are inserted primarily as visual aids; they indicate *no choice* on the basis of a particular criterion. Thus while Child 1 selected Child 2 both as luncheon and play associate, he did not choose him at all as movie companion.

TABLE 3

TABULATION OF SOCIOMETRIC CHOICES

	Subjects															
Subjects	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1		120	200								010		002			001
2	001					200					120		012			
3	002					100		010								221
4						102					220	001	010			
5			200				001				020					112
6				200							111		020			002
7					100			202					010			021
8	001		100				202				010		020			
9											222					111
10						200	001	010				020				102
11		002		200		011							020			100
12					002	200	020				001			100	010	
13		110							201		002				020	
14				020					001		200		010		100	002
15	002	200				100						020	010			
16			100				011				222					
Totals																
Luncheon	0	3	4	2	1	6	1	1	1	0	6	0	0	1	1	5
Schoolwork	0	2	0	1	0	1	2	2	0	0	8	2	8	0	2	4
Movie	4	1	0	0	1	2	4	1	2	0	5	1	2	0	0	8
Social Status Raw Score	4	6	4	3	2	9	7	4	3	0	19	3	10	1	3	17

ond choices from Child 3 and Child 15. All four selections were awarded solely on the basis of the movie criterion.

Reciprocated choices are indicated by underlining. As explained below, for the present experiment, a mutual choice was defined in terms of each criterion taken separately. Thus though Child 1 and Child 2 both selected each other, the relationship does not constitute a mutual choice inasmuch as selections were based on different criteria.

The number of choices received by each child for each criterion, as well as the total number received for all three criteria taken together, appears at the bottom of each column. As explained immediately below, in summing choices, order of preference was disregarded; each selection, no matter whether a first or second choice, was counted as a single unit. For example, Child 11 was selected 6 times as luncheon associate, 8 times as workmate, and 5 times as movies companion; he received 19 choices in all.

Since all data are recorded exactly as obtained the chart presents a complete summary of the test results, obviates the necessity of referring to the original questionnaires, and permits detailed analysis of all choices and choice patterns.

Definition of Sociometric Units and Elements. Since in the situation under discussion several criteria were utilized simultaneously, it was necessary to define units of sociometric relationship rigidly. For reasons growing out of clinical experience the actual number of *choices* received by the child rather than the number of *different persons* by whom he was chosen was selected as the indicator of social status; that is, as seen in Table 3, the choices awarded on the basis of each criterion were tabulated separately, and then, regardless of whether selections came from the same or from different children, the three sums (one for each criterion) were added together to yield a grand total or social status raw score. In Table 3 this score appears at the bottom of each column.

For purposes of scoring no distinction was made between first and second choices. Other investigators, notably Northway (23, 24) have assigned differential weights on the basis of order of preference, but while "reasons for assigning the particular values" were promised (23:145) these do not appear in the indicated reference (24). Several considerations prompted the present investigator to dispense with a weighting procedure: 1) To determine the difference in social significance between a first, second third, etc., choice is a difficult problem. 2) The assigning of arbitrary *a priori* values is a questionable practice. 3) The setting up of the analogous chance situation is much complicated by the adoption of a weighting scheme. 4) In any particular problem, such as a case study, the detailed analysis of choices is in any event advisable. In view of these facts, differential values have not been assigned in the researches reported in this paper.

Consistent with the practice outlined above, other units of sociometric relationship may be defined so as to neglect differences in level of choice but preserve distinctions between criteria. Geometrically, all selections for a given criterion may be viewed as lying in the same plane, while choices for the several criteria may be regarded as lying in separate, distinct planes. Relationships between planes are not recognized. Thus a mutual choice occurs only when a choice on a given criterion is reciprocated on the basis of the *same* criterion. For example, if John selects Tom as first choice for play companion while Tom chooses John as work companion only, this does *not* constitute a mutual choice as defined for the purpose of this analysis. On the other hand, if Tom reciprocates John's selection by a first *or second* choice on the basis of the *play* criterion, the relationship does represent a mutual choice. Two children may be involved in as many as three mutual choices, one for each criterion.

Similarly, unreciprocated choices are defined solely in terms of a single criterion. If Mary chooses Sue as a play companion while Sue chooses Mary as workmate and movie associate but not as a play companion, Mary's selection of Sue remains an unreciprocated choice. It is quite possible, then, for two children to be involved in a mutual choice on the basis of one criterion, be participants in an unreciprocated choice in another, and be entirely unrelated in the third.

As thus defined, mutual and unreciprocated choices cannot both be regarded as independent variables. As pointed out in the preceding chapter, when one value is determined, the other becomes automatically fixed. Consequently, in the mathematical analysis of the problem, it will be sufficient to deal with reciprocated choices only.

As was indicated on page 25, the isolate is clearly defined regardless of the character and complexity of the given sociometric situation as a person receiving no choices whatsoever.

Computation of Social Status Indices. As seen from Table 3, the raw scores received by the sixteen children in the group range in magnitude from 0 to 19. To convert these into indices of social status it is first necessary to determine p, the probability that a given individual will be selected by any other individual in the group merely by chance. This probability is given by Equaton i.

$$p = \frac{d}{N-1}$$

Since *d*, the number of choices allotted each person, equals 2 and *N*, the number of children, equals 16, substitution yields:

$$P = \frac{2}{15}.$$

The value for $q = 1 - p$ is of course $\frac{13}{15}$.

The next step is the determination of the binomial exponent. As indicated above, when three criteria are used the appropriate exponent is given by the expression $3(N - 1) = 45$. The complete binomial to be expanded may now be written as follows:

$$(q + p)^n = \left(\frac{13}{15} + \frac{2}{15}\right)^{45}$$

The succesive terms of the expansion of this binomial will give the probability that any person will be selected by chance 0, 1, 2, 3 . . . 45 times. Since the highest number of choices secured by any child in the sociometric test was 19, approximations for the sum of the first one to twenty terms in the series are required. The approximations are made by reference to the appropriate Type III Curve. Evaluation of the three elementary functions for the Curve (Equations xi, xii, xiii) yields:

$$M = np = 45 \cdot \frac{2}{15} = 6$$

$$\sigma = \sqrt{npq} = \sqrt{45 \cdot \frac{2}{15} \cdot \frac{13}{15}} = 2.28$$

$$a_3 = \frac{q - p}{\sigma} = \frac{11}{15} \cdot \frac{1}{2.28} = .32 \cdot$$

It is now possible to derive the standard score equivalent (t) for each cumulative choice frequency. Following Carver's notation (49:257)

$$t = \frac{x - M}{\sigma} \qquad \text{(xxvi)}$$

where x is the appropriate limit of the interval wherein the raw score value lies. Calculation of t is greatly facilitated by the use of a computing machine. Table 4 illustrates the complete computation for the problem under consideration. The procedure followed is that utilized by Carver (49:233-57). The raw score (s) appears in Column I. Since the desired probability is that of receiving by chance *s or less* choices, the value to be substituted for x in Equation xxvi is the upper limit (L) of the class inter-

TABLE 4

THE COMPUTATION OF SOCIAL STATUS INDICES

I	II	III	IV	V
Number of Choices received	Upper Limit	Raw Score Deviation	Standard Score Equivalent	Probability of Chance Occurrence
s	L	L — M	$\frac{L-M}{\sigma}$	P_s
0	.5	— 5.5	—2.41	.003013
1	1.5	— 4.5	—1.97	.015581
2	2.5	— 3.5	—1.53	.053189
3	3.5	— 2.5	—1.10	.132139
4	4.5	— 1.5	— .66	.263471
5	5.5	— .5	— .22	.431600
6	6.5	+ .5	+ .22	.605464
7	7.5	+ 1.5	+ .66	.754596
8	8.5	+ 2.5	+1.10	.863045
9	9.5	+ 3.5	+1.53	.929978
10	10.5	+ 4.5	+1.97	.968036
11	11.5	+ 5.5	+2.41	.986702
12	12.5	+ 6.5	+2.85	.994927
13	13.5	+ 7.5	+3.28	.998170
14	14.5	+ 8.5	+3.72	.999402
15	15.5	+ 9.5	+4.16	.999818
16	16.5	+10.5	+4.60	.999948
17	17.5	+11.5	+5.04	.999986
18	18.5	+12.5	+5.48	.999996
19	19.5	+13.5	+5.91	.999999

val; this limit is recorded in Column II. The raw score deviation (L—M) is given in Column III and the standard score equivalent $\frac{L-M}{\sigma}$ appears in Column IV. (In machine computation this last value is most conveniently obtained by using the reciprocal $\frac{1}{\sigma}$.) The probability of chance occurrence (P_s) corresponding to the standard score is read directly from Salvosa's tables (48) under the appropriate skewness, which in the present instance is .3. The probabilities recorded in Column V, or their complements, represent the desired indices of social status.

The indices may be interpreted as follows: Child 10, who received no choices at all, would have been totally overlooked by chance only about three times in a thousand ($P_s = .003$). Since it is unreasonable to suppose that so improbable an event actually occurred, it appears justifiable to attribute the neglect of his classmates not to fortuitous circumstances but to socially determined behavior. On the other hand, Child 11, who was selected 19 times in all, would have received as many choices by chance only four times in a million.[10] Consequently, it follows that factors other than chance must have accounted for the high frequency of selection. These factors may be conveniently viewed as components of social forces the resultant of which determined the child's position in the group.[11]

Computation of the Index of Coherence. The total number of mutual choices formed on the basis of the three criteria taken separately was 13. To determine the probability that as many as 13 mutual choices will be obtained merely by chance, it is necessary to compute the chance likelihood that a single mutual choice will occur. This value is calculated from Equation ii.

$$P_m = P^2 = \left(\frac{2}{15}\right)^2 = \frac{4}{225}.$$

The complement (q_m) is of course $1 - p_m = \frac{221}{225}$. As indicated on page 382, the corresponding binomial exponent is given by the expression $3 \cdot {}_NC_2$, which after the proper substitution and simplification yields

$$3\ {}_NC_2 = \frac{3N(N-1)}{2} = \frac{(3)(16)(15)}{2} = 360.$$

Consequently, the binomial expression to be expanded is

$$\left(\frac{221}{225} + \frac{4}{225}\right)^{360}$$

By substituting values from the above expressions for p, q, and n in Equations xi, xii, xiii, the three elementary functions for the appropriate Type III Curve are found to be

$$M = 360 \cdot \frac{4}{225} = 6.4$$

$$\sigma = \sqrt{360 \cdot \frac{4}{225} \cdot \frac{221}{225}} = 2.51$$

$$a_3 = \frac{217}{225} \cdot \frac{1}{2.51} = .38.$$

---

[10] The value in Column V of Table 4 indicates the probability that a person will be chosen by chance *s or less times.* Thus the probability that a child will be selected by chance *19 or fewer* times is .999999, while the probability that he will be chosen *18* or fewer times is .999996. Consequently, the chance likelihood of being chosen *19 or more* times is given by the complement, $1 - .999996 = .000004$.

[11] The results of the above procedure demonstrate statistically significant results only for children at either extremes of the distribution. The phenomena occurring in the middle range are not treated in the present paper; however, the methods developed here can be extended to this problem. *E.g.*, one may determine whether the number of persons receiving a given score at any point of the distribution differs significantly from chance expectancy.

Since the obtained number of mutual choices (13) is greater than the expected or mean value of 6.4, the required probability is the likelihood that 13 *or more* mutual choices will occur by chance. Consequently, the mean value is subtracted from the *lower* limit of 12.5 yielding a raw score deviation $+6.1$, which divided by the sigma of 2.51 gives a standard score equivalent of $+2.43$. In Salvosa's tables the corresponding entry under a skewness of .4 shows a probability value of .014. This signifies that in a chance situation as many as 13 mutual choices will occur less than two times in a hundred. The obtained frequency is thus sufficiently in excess of chance expectancy (see page 10) to be regarded as indicating a significantly high degree of group coherence.

This last statement should not be interpreted as implying that the group under discussion possessed a higher degree of coherence than other social groups. The evidence indicates merely that a statistically significant level of group solidarity was present. In comparison with the degree of coherence manifested in other groups, this level may be unusually high, unusually low, or average. Experimental data from numerous sociometric situations will be necessary before accurate evaluation can be made.[12]

Computation of the Index of Isolation. Only one isolate was revealed by the sociometric test. Substituting this integer for i in Equation xxv yields the following result:

$$P_i = 1 - \frac{13.12}{15.14} = .257.$$

Since three criteria are being utilized, the required index is given not by P_i but by $(P_i)^3$ or .016 (see page 26). The probability that there will be as few as one isolate in the chance situation is thus less than two in a hundred. Consequently, the obtained index corroborates the evidence for the presence of group solidarity.

Computation of Indices of Cleavage. The indices of cleavage to be calculated are those for inter-sex choice. The probabilities that a girl will choose a boy and that a boy will choose a girl merely by chance are given by Equations xxiii, xxiv. With four girls and twelve boys in the group, substitution yields the following values:

$$P_{g-b} = \frac{b}{N-1} = \frac{12}{15}$$

$$P_{b-g} = \frac{g}{N-1} = \frac{4}{15}$$

---

[12] An exploratory comparative study of the degree of social coherence in various classroom groups is presented in Part III.

As indicated on page 24, the corresponding exponents are respectively $3gd = 24$ and $3bd = 72$, where d, the number of choices allotted, is 2. Thus the binomial expression for determining the successive probabilites of girl-boy choice is $\left(\frac{3}{15} + \frac{12}{15}\right)^{24}$ and that for boy-girl choice is $\left(\frac{11}{15} + \frac{4}{15}\right)^{72}$. Substituting in Equations xi, xii, xiii the appropriate terms from the expressions above yields the following values for the elementary functions for the two Type III Curves:

$$M_{g-b} = 24 \cdot \frac{12}{15} = 19.20$$

$$\sigma = \sqrt{(19.20) \cdot \frac{3}{15}} = 1.96$$

$$\alpha_3 = -\frac{9}{15} \cdot \frac{1}{1.96} = -.31$$

$$M_{b-g} = 72 \cdot \frac{4}{15} = 19.20$$

$$\sigma = \sqrt{(19.20 \cdot \frac{11}{15}} = 3.75$$

$$\alpha_3 = \frac{7}{15} \cdot \frac{1}{3.75} = .12\,.$$

The means are equal because the functions are complementary.

In the sociometric test, there were 11 choices of boys by girls and 16 choices of girls by boys. Since both of these scores are below the expected mean value of 19.20, the desired probabilities are obtained by using the *upper* limit of the class interval. Substituting in Equation xxvi yields the following standard score equivalents:

$$t_{g-b} = \frac{11.50 - 19.20}{1.96} = -3.93$$

$$t_{b-g} = \frac{16.50 - 19{\cdot}20}{3.75} = -\ .72\,.$$

Reading from the tables under the appropriate α_3 values of —.3[13] and +.1

---

[13] Since the complete distribution would be symmetrical, only positive values for α_3 are given in Salvosa's tables. Where the skewness is negative, the appropriate probabilities are obtained by changing the sign of α_3 and the standard score equivalent. For example, in the above instance ($\alpha_3 = -.3$; $t_{g-b} = -3.93$), the requisite value is secured by reading from the tables, under a skewness of + .3 the probability corresponding to a standard score equivalent of + 3.93.

yields the following results: The chance probability that a girl will choose a boy as few as 11 times is .0004; the probability that a boy will choose a girl as few as 16 times is .24. These values indicate that both for boys and girls the number of inter-sex choices was a good deal less than might have been expected on the basis of chance and that the number of girl-boy choices was sufficiently small to be regarded as highly significant statistically.

To summarize: Analysis of sociometric results in terms of deviation from chance expectancy reveals: 1) that in several instances the number of choices received by particular children was so small or so large as to establish the existence of social deviates at either end of the scale; 2) that the frequency of mutual choices was so high and that of isolates so low as to indicate the presence of group solidarity; 3) that inter-sex choices particularly choices of boys by girls, were so infrequent as to demonstrate a considerable degree of group cleavage along sex lines.

PART II. THE GRAPHIC PRESENTATION OF SOCIOMETRIC DATA

It is customary to present the results of sociometric testing by means of a diagram (called a sociogram) illustrating the choices given and received by various members of the group. The purpose of such a diagram is to provide a picture of the sociometric structure and thus enable an observer quickly to determine the status of any member of the group, to identify the leaders and the unaccepted, and to obtain some indication of the combinations, cliques, and cleavages into which the social unit may be subdivided.

As originally developed by Moreno,[14] the sociogram was of the form illustrated in Figure A. This diagram shows all the choices made by the sixteen pupils in a third-grade classroom. Each child had been asked to select two others as preferred companions at lunch. The children are identified by number; girls appear at the right side of the diagram, boys at the left. Mutually reciprocated choices are indicated by double-headed arrows with short cross-bars at the middle of the shaft. The arrangement of subjects on the diagram, while haphazard in part, is determined largely by trial and error with the aim of minimizing the number of intersecting lines.

Such a diagram has obvious advantages over a verbal or tabular means of presentation. In its general principles, it represents the prototype for all subsequent developments. In its specific form, however, it has certain limitations from the point of view of ready interpretation. A sociogram of this type is frequently confusing to the eye, and, in general, is ill-adapted for the analysis and comparison of sociometric structure. For example, in Figure A it is hardly apparent at first glance just who chooses whom, who are the stars and isolates, and what are the mutual choices, cliques, and cleavages that may be present in the structure. The data here depicted are for a comparatively small group. The confusing diagrams that may result in the case of larger groups are strikingly demonstrated in the figures appearing on pages 124-129 of Moreno's definitive monograph.[15]

Many of the above inadequacies are remedied in an adaptation of the sociogram developed by Northway.[16] This method, appropriately referred to

---

[14] Moreno, J. L., *Who Shall Survive?*, obtainable at Beacon House, New York, N. Y., 1934.

[15] Moreno, J. L., *op. cit.*

[16] Northway, Mary L., "A Method for Depicting Social Relationships by Sociometric Testing," *Sociometry,* Vol. III, No. 2, April, 1940.

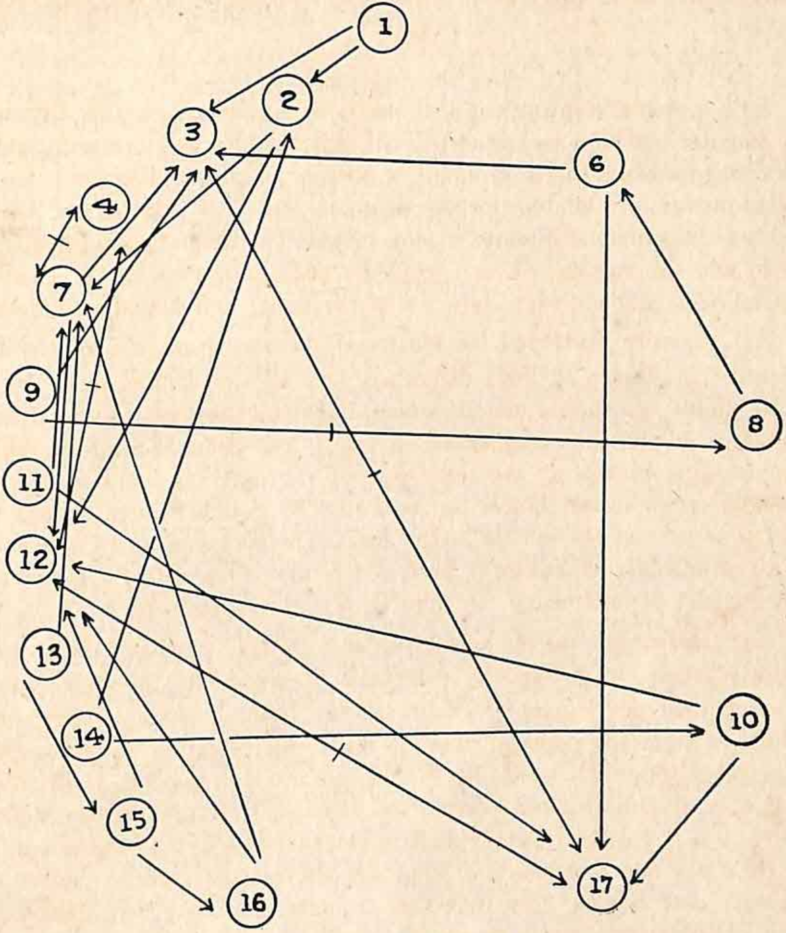

FIG. A.—SOCIOGRAM
for
a Third Grade

Girls	4
Boys	12
Total	16

Criterion:
Luncheon preference

as the "target technique," is described by Northway as follows:[17]

> Four concentric circles whose radii increase are drawn by equal steps. The acceptability scores (based on the total number of choices received by each person) are divided into quartiles . . . The lowest quartile is on the outside of the target and the highest in the middle. Each subject is placed on the target in the quartile [*sic*] to which his

---

[17] *Idem*, page 148.

acceptability score belongs. The nearer he is to the center, the higher his score is.

It will be noted that since the quartile, like the percentile, is not an area but a point, Northway's use of the term is not strictly accurate. The term "quarter" is more appropriate and will be utilized in subsequent discussion when areas rather than points are being considered.

The advantages of Northway's method of presentation are best illustrated by an example. Figure B shows the data of Figure A presented

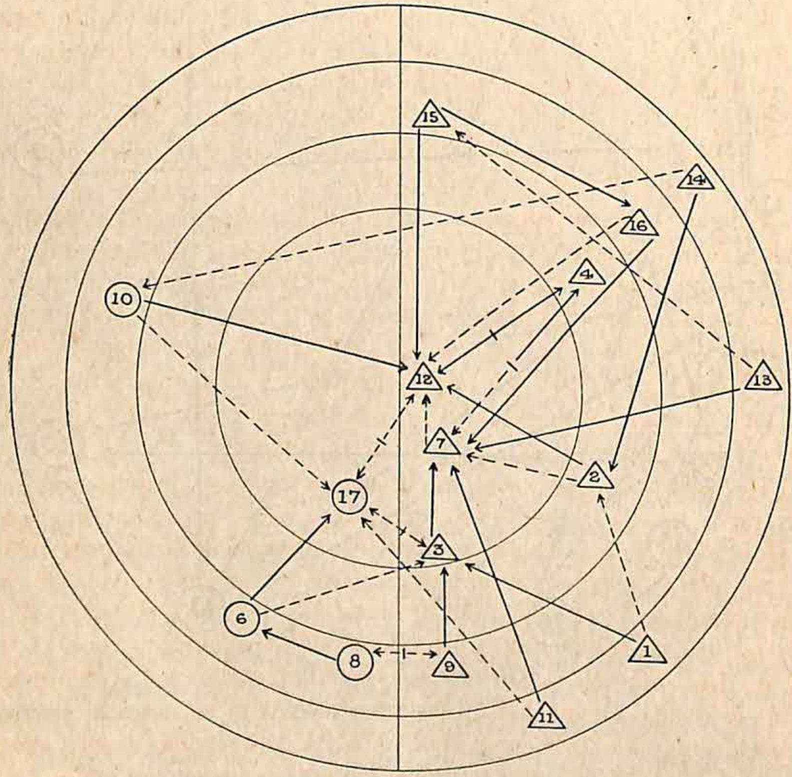

FIG. B.—SOCIOGRAM

For a Third Grade Group

Criterion:
Luncheon preference

Circle is divided into quarters.
Highest quarter (children chosen most often) is in center.
Lowest quarter (children chosen least often) is on the outside.

Girls	4
Boys	12
Total	16

Mutual choices	5
Girls' choices of boys	5
Boys' choices of girls	5

by means of the target technique. It will be observed that in Figure B the significant aspects of sociometric status are more quickly apparent. In particular, since the rank order of individuals is preserved, the stars in the center and the isolates on the periphery are immediately distinguishable.

The Northway technique is highly adaptable and permits advantageous additions and modifications. Some of these have been adopted in Figure B. Small circles and triangles (consistent with Moreno's usage) have been employed as differential symbols for girls and boys respectively and the target has been subdivided vertically so that inter-sex choices are readily apparent. A similar division may be utilized in the study of other cleavage groups. To provide an appropriate and consistent scale for drawing, the radii of successive circles have been adjusted so that the area of each division is equal to one-quarter that of the whole target. Solid and broken lines denote first and second choices respectively.

In more complex situations, where indicating all choices results in a chaotic diagram, various adjustments are possible. When selections are made on the basis of a single criterion, it is often convenient to show first choices only. In groups where several criteria are utilized simultaneously, the writer has found it practical to indicate only the constellations[18] of mutual choices (See Figure C). Using such a constellation diagram as a master sheet, one may prepare "case studies" by superimposing all selections made or received by a particular person or group of persons.

The quartile-target device as developed by Northway is quite satisfactory for the sociometric study of a single social group the membership of which remains reasonably constant. If, however, it is the investigator's purpose to compare the sociometric status of persons in a group or several groups varying in size, certain modifications become necessary. As has been pointed out previously, conventional statistical indices such as ranks and quartiles—as well as raw scores, percentiles, ratios, and standard scores—are not wholly acceptable as measures of comparative status in diverse sociometric situations. In view of this fact, Northway's procedure of dividing the target into quarters and arranging subjects in order of rank is not entirely suitable in most sociometric studies where several groups are involved or where the same group changes markedly in size over a period of time. In such situations it becomes necessary to utilize an index which

---

[18] As here used, the term "constellation" denotes any continuous network of mutual choices.

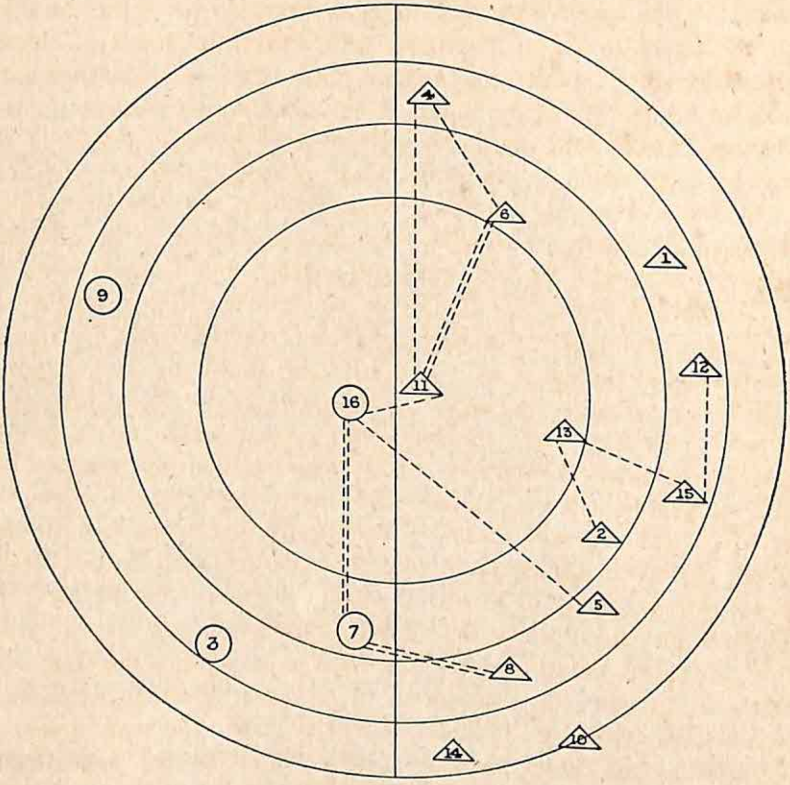

FIG. C.—SOCIOGRAM

Grade III

Girls	4
Boys	12
Total	16
Mutuals	13
Isolates	1

Chance likelihood of falling—

within innermost circle	.02 or less
within second circle	.50
outside second circle	.50
outside third circle	.02 or less

Criteria:
luncheon choice
schoolwork choice
movie choice

Broken lines show constellations of mutuals

Girl-boy choices (not shown)	11
Boy-girl choices (not shown)	16

has uniform significance regardless of the size of the group. Such an index has been developed by the writer through application of the concept of deviation from chance expectancy. Utilization of this concept also permits the evaluation of statistical significance.[19] The index may be readily incorporated in the target form of graphic presentation by fixing the divisions of the target so as to correspond with differential levels of chance expectancy. Figure C shows a sociogram constructed in accordance with the above principle. The figure is based on data from a sociometric test involving two choices with respect to each of three criteria—a total of six selections by each person in the group. Since to depict all of these choices would produce a hopelessly confusing diagram, only the constellations of mutual choice are shown. It will be noted that in Figure C the divisions of the target no longer set off successive quarters but instead delineate differential levels of chance selection. Thus children receiving a number of choices so great as to be statistically significant (*i.e.* occurring by chance only two or fewer times out of a hundred) are shown in the innermost circle, those nearest the center being the most frequently chosen. Moreno's term "star"[20] may legitimately be applied to persons within this area and the limit of statistical significance (.02) may be used for making the definition of stardom more rigorous and precise. Children receiving a number of choices so *small* as to be statistically significant (probability .02 or less) appear in the outermost ring of the target, with isolates shown on the extreme periphery. The second circle designates the 50 per cent or expected value, about which the majority of the subjects are clustered.

---

[19] See pages 10-11.

The principles and procedures involved in computing an index of sociometric status based on the concept of deviation from chance expectancy have been discussed in full. For the most common types of sociometric situations tables have been prepared giving the approximate raw score values corresponding to the 50 per cent level and to the positive and negative limits of statistical significance.[21] Through the use of these tables it is possible to read directly the raw score values to be assigned to each circular division on the target. Thus the amount of computation required for determining boundaries for a target sociogram of this type becomes even less than that involved in determining successive quartiles.

The fact that in sociometric tests persons are chosen so few or so many times as to yield statistically significant results points to the conclusion that factors other than chance must account for extreme positive and negative deviations in sociometric status. It appears both convenient and reasonable to proceed on the assumption that these factors are in the nature of components of social forces the resultant of which determines the subject's position in the group.[22] It would follow from this hypothesis that the persons shown in the central and peripheral areas of the target are those most markedly affected by the social forces of preference and avoidance operative in the group. In this connection it is of interest to consider an analogy between the sociometric target and a revolving wheel. It will be recalled that for any rotating body there is a centrifugal force which tends to impel the object outward from the center of rotation. For the object to stay fixed in the orbit of revolution, the centrifugal force must be counter-balanced by an equal and opposite centripetal force. If the latter force is not sufficiently great, the object will be ejected from the physical system. Similarly, if the sociometric target is thought of as revolving, social forces of attraction may be likened to centripetal force, while forces of rejection may be compared to centrifugal force.[23] When the former are not sufficiently great, or when the latter are unduly strong, the subject will tend to move toward the periphery of the target. To carry the analogy further, isolates may be regarded as those who either because of neglect (*i.e.* lack of attraction between themselves and other members of the group) or rejection (active expulsion by one's companions) are being forced from the field.

---

[20] Moreno, J. L., *op. cit.* page 34.

[21] Bronfenbrenner, U., "Experiment and Inference," part III of this monograph, page 71.

It is thus fitting that they be represented on the rim of the target.[24] This analogy, however, should not be carried too far. First of all, it is not rigorous, inasmuch as in the one instance the focal point is a center of rotation whereas in the other it is the mean or expected value represented not by the dead center of the target but by a circle lying between that center and the outermost edge. Moreover, in a sociometric situation there is no real counterpart to a force derived from circular motion. Finally, it is always hazardous to draw comparisons between physical and social or psychological phenomena, for, with the latter, the "personal equation" instead of representing an almost negligible element of error, constitutes, in a broad sense, the principal function to be investigated.

---

[22] Moreno has used the term "tele" to describe the basic element presumably involved in such social forces; he defines tele as "the simplest unit of feeling transmitted from one individual to another" (Moreno, J. L., *op. cit.*, page 432).

[23] It is of interest to recall further that as both centrifugal and centripetal force are determined by computing the second moment, so, in like manner, deviations from chance expectancy are also functions of the second moment (see page 18). Indeed, the *sigma*, or standard deviation is a strict analogue of the physicist's radius of gyration.

[24] It is worthy of note that this last aspect of the analogy finds confirmation in clinical and experimental results even to the extent of anticipating the two-fold classification of isolates into "neglectees" and "rejectees" (see "Experiment and Inference," part III of this monograph, footnote, page 74).

PART III. EXPERIMENT AND INFERENCE

INTRODUCTION

In Part I of the present paper the writer discussed certain major difficulties involved in the interpretation and comparison of sociometric data. It was pointed out that no adequate methods had been developed for comparing results of sociometric tests for groups differing in size. As a solution the writer proposed the development of a constant frame of reference through application of the deviation-from-chance-expectancy concept. It was shown that by comparing the results obtained in a sociometric test to those secured in a mathematically analogous chance situation (*e.g.*, drawing names from a hat) it is possible not only to identify statistically significant data but also to interpret results obtained from mathematically diverse sociometric situations. Procedures and formulas for obviating computational difficulties presented by the technique were developed and the application of the method was illustrated.

In Part II the writer attempted a graphic presentation of sociometric data.

In Part III, which is to follow, the writer demonstrates some of the types of experimental analysis made possible by the refinements in sociometric technique described in Part I. The experiments to be reported are significant not in terms of yielding conclusive results, but rather in terms of defining problems, providing specific approaches for their solution, revealing pitfalls, eliminating blind alleys, illustrating the general scope and character of results that may be obtained, suggesting hypotheses, and delineating areas for subsequent intensive investigation. Specifically, an attempt was made in these experiments to pave the way for the longitudinal study of sociometric status, structure, and development in groups of varying size.

SECTION 1

THE EXPERIMENTAL SETTING[25]

Subjects and Groups. A sociometric analysis was made of the entire population of the laboratory elementary school at the University of Michigan. This population included children from the nursery to the sixth grade level, but inasmuch as the four upper grades had been combined into two classes, there were but six separate social groups in all: Nursery, Kindergarten, Grade I, Grade II, Grade III-IV, and Grade V-VI. The groups ranged in size from fourteen to thirty-three. The demands of the war had created greater family mobility in the university community so that withdrawals and new entrants were more frequent than they had been in previous years. In general, classes became smaller over the period during which the study was in progress. The specific constitution of the groups tested is given in Table V. Column I gives the age range at the beginning of the experiment. (The turnover in pupil personnel was not sufficient to require specification of age distributions at subsequent periods). The columns which follow give dates, size of group, and the distribution and ratio of sexes for each sociometric test administered. The last column indicates the number of *permanent* subjects in each group—that is, the number of subjects who were present for all sociometric tests.

---

[25] Grateful acknowledgment is extended to Dr. Willard C. Olson, Director of the University Elementary School at the University of Michigan and to the teaching staff for their cooperation in administering the sociometric tests.

With regard to intelligence and achievement, the subjects unquestionably represented a highly-selected group. The average IQ's (Kuhlmann- and Stanford-Binet)[26] for each of the six classes ranged from 110 to 130 and average scores on achievement tests[27] were, on the whole, well above national norms.

Selection and Formulation of Criteria. Experience with preliminary studies showed that great care is necessary in the selection of sociometric criteria and the formulation of questions embodying these criteria. Unless the activity is familiar to the members of the group, unless all members are equally free to participate in the activity, unless preference is not influenced by extraneous environmental factors, and unless the nature of the choice is clearly conveyed by the question, the results of the sociometric analysis may easily be invalidated. For example, such a question as "With whom would you like to go to the movies?" was found to give biased results, since children tended to select those who lived nearest in their own community. It is of course impossible to anticipate all such sources of bias, or even to eliminate them once they are known. Indeed, it may not even be desirable to attempt to eliminate *in toto* the effects of such a factor as living in proximity, for this condition constitutes a genuine fostering influence in social growth.

---

[26] *The Kuhlmann Binet-Simon Test.* Baltimore, Maryland: Warwick and York, Inc., 1922. *The Revised Stanford-Binet Scales.* Boston: Houghton Mifflin Company, 1937.

[27] *Gates Primary Reading Test.* New York: Bureau of Publications, Teachers College, Columbia University, 1926. *Stanford Achievement Test.* Yonkers-on-Hudson, New York.

TABLE V

CONSTITUTION OF GROUPS AT TIME OF EACH SOCIOMETRIC TEST

Group	Age Range in Months at First Testing Period	Fall Sociometric Test						Spring Sociometric Test						Number Permanent Cases
		Date	Size of Group	Number Boys	Per Cent Boys	Number Girls	Per Cent Girls	Date	Size of Group	Number Boys	Per Cent Boys	Number Girls	Per Cent Girls	
Nursery	33-53	10-41	18	9	50	9	50	5-42	16	8	50	8	50	14
Kindergarten	55-66	10-41	25	14	56	11	44	5-42	21	9	43	12	57	20
Grade I	64-79	10-41	26	13	50	13	50	3-42	22	12	55	10	45	21
Grade II	79-106	10-41	18	10	56	8	44	3-42	14	8	57	6	43	14
Grade III-IV	87-121	10-41	33	13	39	20	61	3-42	29	12	41	17	59	29
Grade V-VI	115-146	10-41	31	23	74	8	26	3-42	31	22	71	9	29	29
Total			151	82	54	69	46		133	71	53	62	47	127

However, it is important to avoid ambiguous or "heavily loaded" questions which may influence results in an undetermined but perhaps highly marked fashion.

To provide a common basis for comparison, it was necessary to utilize the same criterion in all six classes. Since the groups varied widely among themselves in age and interest of subjects, it was extremely difficult to find activities or situations which were reasonably common for children in all six grades. For several days the classes were observed carefully in their customary pursuits and a list of possible criteria compiled. This list was checked for each group and items eliminated when necessary until three general types of situation remained as commonly observed at all school levels. These three were taken as criteria for a sociometric questionnaire with questions formulated as follows:

1. With what children would you like to work best?
2. With what children would you like to play best?
3. What children would you like to have sit near you?

It is evident that though these questions may have referred to situations found among all age levels in the school, it is hardly likely that children in successive grade groups differentiated between activities to the same degree. Since there was no way to eliminate differences in interpretation or discrimination, an attempt to estimate the degree of variation was made by means of a correlational analysis with respect to choices received on the basis of the several criteria taken separately. The results of this analysis are presented in a succeeding section.

It will be noted that the questions are all phrased positively; that is, the children were not asked to name those whom they would *dislike* as companions. Despite the fact that they might contribute valuable information concerning the degree and character of social rejection, negative questions were avoided because of their possible effect, by calling attention to the less-favored children in each group, of fostering discrimination and thus causing even more severe social maladjustment.

Administration of the Questionnaire. Since children in the lower grades could not read fluently and since a uniform procedure was desirable, the questionnaire was administered at all levels in interview form. In the hope of providing a relatively consistent and high degree of rapport, the home room teacher was asked to do the interviewing herself. The purpose of the experimentation was explained to the teachers at a staff meeting and the following written instructions were presented:

The interview should be conducted in a natural and informal fashion.

Creating an atmosphere of casual routine will minimize the likelihood of children's discussing choice among themselves.

So that chance presence or absence of certain pupils will not affect the results unduly, it is advisable to conduct the interview while most of the children are within view, but of course not within hearing.

Procedure. Say to the child: I WOULD LIKE TO KNOW WHICH CHILDREN IN THIS ROOM WORK AND PLAY BEST TOGETHER. WOULD YOU TELL ME WHICH CHILDREN YOU WOULD LIKE TO BE MITH MOST? CHOOSE ANYONE YOU WISH; YOUR CHOICES WILL NOT BE MENTIONED TO ANYONE ELSE.

Then ask the three questions above, emphasizing the underlined words. Note the child's responses on the record blank. Do *not* ask for three choices specifically. If the child names but one or two, say: IS THERE ANYONE ELSE? If no additional response is made, leave the item blank. Record no more than three responses for each question.

The questions asked have already been presented. The underlined word in each question was the verb describing the criterion. The reason for avoiding insistence on *exactly three* responses was to minimize the possibility of a child's expressing a preference he did not actually feel.

The questionnaire was administered on a school-wide basis during the academic year 1941-42. Two complete sociometric tests were made in each grade—the first test early in the fall of the year, the second during the spring semester. Except for a few absent children, all fall questionnaires were filled out during the third week of October. Absentees were asked to indicate their choices upon the first day of their return to school, which in no instance was longer than two weeks after the main group had been tested. Administrative considerations prevented the giving of spring questionnaires for all classes in the same week. In Grades I through V-VI, the sociometric test was administered during the last week in March; in the two youngest groups, questionnaires were filled out during the last week in May. The procedure for administration was identical in all tests.

Tabulation and Treatment of Data. The child's responses were recorded by the teacher and tabulated by the investigator in accordance with the procedure outlined in Part I. At first, separate totals were computed both for the number of *choices* received by each child and for the number of *different* persons by whom he was chosen. Indices of status, coherence, etc. based on both types of unit were then calculated in order to determine which kind was the more sensitive indicator of sociometric relationship In view of considerations outlined below, the *choice* was selected as the unit best adapted for fine discrimination in sociometric measurement.

The Selection of Sociometric Units. A comparison of indices based on both types of unit revealed that while negative deviations from the expected value were equally marked in one or the other distribution, extreme deviations *in excess* of chance expectancy were obtained only when the number of *choices* rather than the number of *different persons* choosing was utilized for computing indices. This fact is illustrated by the data in Table VI, which shows the results for the fall sociometric test made in the Grade III-IV group. The number of choices received by each child and the number of different persons by whom these choices were made are given along with the corresponding probabilities of chance occurrence. In interpreting the latter, it should be recalled that the probability cited is the likelihood that *at most* the given score will be obtained by chance. Probabilities greater than .50 indicate events in excess of chance expectancy; indices smaller than .50 denote negative deviations from the expected value.

When the two raw scores made by each child are compared, it will be noted that the number of *different persons* is almost without exception smaller than the number of *choices* and that this difference becomes more pronounced for higher score values. It will be observed further that not only do the corresponding probabilities of chance occurrence differ, but that values in excess of chance expectancy are found far less frequently among person-scores than among choice-scores. When the former do appear, they do not attain levels of statistical significance.[28]

The above situation is typical for each one of the six groups studied. While the distribution of person-scores above the mean value was similar to that which would have been obtained by drawing names out of a hat, the distribution of choice-scores could have come only from the hat of a magician. Yet, paradoxically enough, the correlation between the number of choices received by each child and the number of different children by whom those choices were made was above +.95±.02 in three of the six groups and above +.90± in all of them.

The phenomenon is explained in terms of social rather than mathematical considerations. In the sociometric situation, each child apparently tends to choose the same persons for more than one criterion. As a result, despite the fact that the two are highly correlated, the number of choices received is usually higher than the number of different persons choosing. Consequently, the variation in choice-score is greater than the variation in person-score. The choice thus becomes the more sensitive indicator of social status and will frequently reveal a statistically significant result left obscure by an index based on the number of different persons choosing.

---

[28] As seen from the table, the highest person-score obtained by any child was 9 and the probability that a score even higher than 9 would have been obtained merely by chance is 1 — .71 or .29. This value does not approach the arbitrary limit of .02 adopted in the study.

TABLE VI

THE NUMBER OF CHOICES RECEIVED BY CHILD, THE NUMBER OF DIFFERENT PERSONS CHOOSING, AND THE CORRESPONDING PROBABILITIES OF CHANCE OCCURRENCE

(Data Taken from the Fall Sociometric Test for Grade III-IV)

Child	Choices Received		Persons Choosing		Child	Choices Received		Persons Choosing	
	Number	Probability of Chance Occurrence	Number	Probability of Chance Occurrence		Number	Probability of Chance Occurrence	Number	Probability of Chance Occurrence
9	0	.0002	0	.0002	2	8	.4477	4	.0621
10	0	.0002	0	.0002	16	8	.4477	4	.0621
20	0	.0002	0	.0002	4	9	.5903	4	.0621
28	0	.0002	0	.0002	6	9	.5903	5	.1360
12	2	.0053	2	.0067	30	9	.5903	4	.0621
29	3	.0182	1	.0015	13	10	.7112	5	.1360
22	3	.0182	3	.0226	26	10	.7112	6	.2538
1	3	.0182	2	.0067	27	11	.8117	5	.1360
32	4	.0470	2	.0067	33	11	.8117	5	.1360
23	4	.0470	2	.0067	19	11	.8117	5	.1360
7	4	.0470	3	.0226	11	11	.8117	7	.4016
5	5	.1052	2	.0067	8	15	.9826	7	.4016
18	5	.1052	3	.0226	15	15	.9826	8	.5646
24	5	.1052	3	.0226	17	15	.9826	7	.4016
21	6	.1948	2	.0067	14	18	.9983	7	.4016
3	7	.3143	4	.0621	25	21	.9999	9	.7102
31	7	.3143	3	.0226					

Similar considerations were found to apply to the alternative definitions of mutual and inter-class choice. In each instance, a count on the basis of relationship between choices rather than between persons more frequently yielded statistically significant indices.[29]

In view of these facts, throughout all subsequent experimentation sociometric elements were defined in terms of *choices* rather than *persons*. The calculation of indices of status, coherence, cleavage, and isolation for the results of each sociometric test was then carried out in accordance with the procedure illustrated in Part I. The results are presented and analyzed in the succeeding section.

SECTION 2

I. ANALYSIS OF TRENDS

Components of Sociometric Status. It is of interest to determine to what extent the particular activity or situation may have influenced the child's choice of a companion—that is, to what degree children at successive age levels discriminated on the basis of the three criteria in their selection of associates. To phrase the question specifically: in general, were the same children chosen as companions for work, for play, and for seating. To supply an answer to this question, rank correlations (ρ) were computed between raw status scores secured by every child on the basis of each criterion taken separately. The correlations were found to vary between +.30 and +.95, with all but two of the thirty-six coefficients faling between +.45 and +.90. The probable errors of these indices ranged from ±.015 to ±.13 with the majority in the neighborhood of +.08. The correlations between *play* and *seating* choices were generally lower than those between *work* and *seating*. As may be expected, *play* and *seating* correlated somewhat more highly in the lower grades; *work* and *seating*, at the higher levels. There were no perceptible trends shown in passing from one grade to the next, but within grades correlation coefficients were generally lower for the spring than for the fall.[30]

The data indicate that children who are accepted on the basis of one criterion are likely to be accepted on the basis of other criteria as well, particularly when the activities or situations are simultaneous or overlapping. However, there is room for considerable variation and as the members of a group become better acquainted, differentiation on the basis of the activity may become slightly more pronounced. The data leave indeterminate the question of whether older children discriminate more finely on the basis of the criteria than children at lower age levels.

---

[29] Indices of coherence based on person-score produced rather curious results; see footnote on page 62 .

[30] Since detailed analysis of all coefficients merely substantiated the results cited above and revealed no consistent trends between groups, a complete tabulation of the thirty-six coefficients and their probable errors was not deemed necessary.

Status Constancy. The degree to which sociometric status remained constant over the five to seven month period between the two sociometric tests in each group is indicated roughly by the magnitude of rank correlation coefficients between the total raw status scores obtained in the fall and spring analyses. The coefficients, along with the number of cases upon which they are based, are presented in Table VII.

It will be noted that the smallest coefficients occur in the groups with

TABLE VII

RANK CORRELATION COEFFICIENTS BETWEEN THE RAW STATUS SCORES OBTAINED BY EACH CHILD IN THE FALL AND SPRING SOCIOMETRIC TESTS

Group	Size of Group	ρ
Nursery	14	+.27±.17
Kindergarten	20	+.67±.08
Grade I	21	+.48±.11
Grade II	14	+.28±.18
Grade III-IV	29	+.52±.09
Grade V-VI	29	+.59±.08

TABLE VIII

PERCENTAGE OF CHILDREN CHOSEN IN EXCESS OF CHANCE EXPECTANCY IN EACH SOCIOMETRIC TEST

Group	Time of Test	Size of Group	Children Chosen in Excess of Chance Expectancy Number	Per Cent
Nursery	Fall	18	2	11
	Spring	16	6	38
Kindergarten	Fall	25	8	32
	Spring	21	9	44
Grade I	Fall	26	8	31
	Spring	22	9	41
Grade II	Fall	18	6	33
	Spring	14	6	44
Grade III-IV	Fall	33	14	42
	Spring	29	12	41
Grade V-VI	Fall	31	13	42
	Spring	31	12	39
Total		284	105	37

the least number of cases. This is not surprising inasmuch as in sociometric situations the number of cases determines the range of scores, and with a wider range it is well known that higher coefficients may be obtained. A further weakness of this correlation technique as a measure of constancy arises from the fact that it is a function of relative status only. If portions of the whole framework shift—for example, if a small group secures higher scores but relative status remains unchanged—the variation is not reflected by the rank correlation coefficient. On the other hand, along with conspicuous changes in status, the coefficient does take into account minor variations in rank which may be purely random. In view of these limitations, it would appear desirable to study the degree of constancy further by methods incorporating the constant frame of reference supplied by the concept of deviation from chance expectancy.

To consider first gross shifts in distribution of status from test to test: Table VIII shows the proportion of children in each group chosen in excess of the expected value. It will be noted that the obtained proportions are consistently smaller than 45 per cent, in other words, less than 40 per cent of the children command half of all available choices in the group. These results are presented graphically in Figure 1. It should be noted that the curve in Figure 1 depicts change both in terms of cross-sectional and longitudinal data. Broken lines show variation from one grade group to the next; solid lines indicate extent of change within the same group after an interval of approximately half a year. The zigzag, "two steps forward, one backward" pattern exhibited in this graph and in others to follow is in all likelihood a product, in part at least, of the dual character of the data. In addition to the trends already cited, the graph reveals a tendency for percentages to increase *within* the grade and to rise gradually in passing from primary to elementary levels. In general, then, the data suggest that in sociometric situations an undue proportion of the choices will be accorded to a minority, and that this proportion will increase slightly as the members of the social structure become better acquainted and more mature.

By utilizing a definition in terms of deviation from chance expectancy, a picture of status constancy independent of the minor, and, in all likelihood, random variations may be obtained. Table IX shows the proportion of children in each group. The graph depicting these data (Figure 2) reveals also an increase in percentage as one passes from lower to higher grade levels. It would appear, then, that sociometric status is maintained more consistently among older children. The rather marked rise occurring between Grade II and Grade III-IV may be explained in part by the fact that the increase which might have occurred from Grade III to Grade IV, were the groups

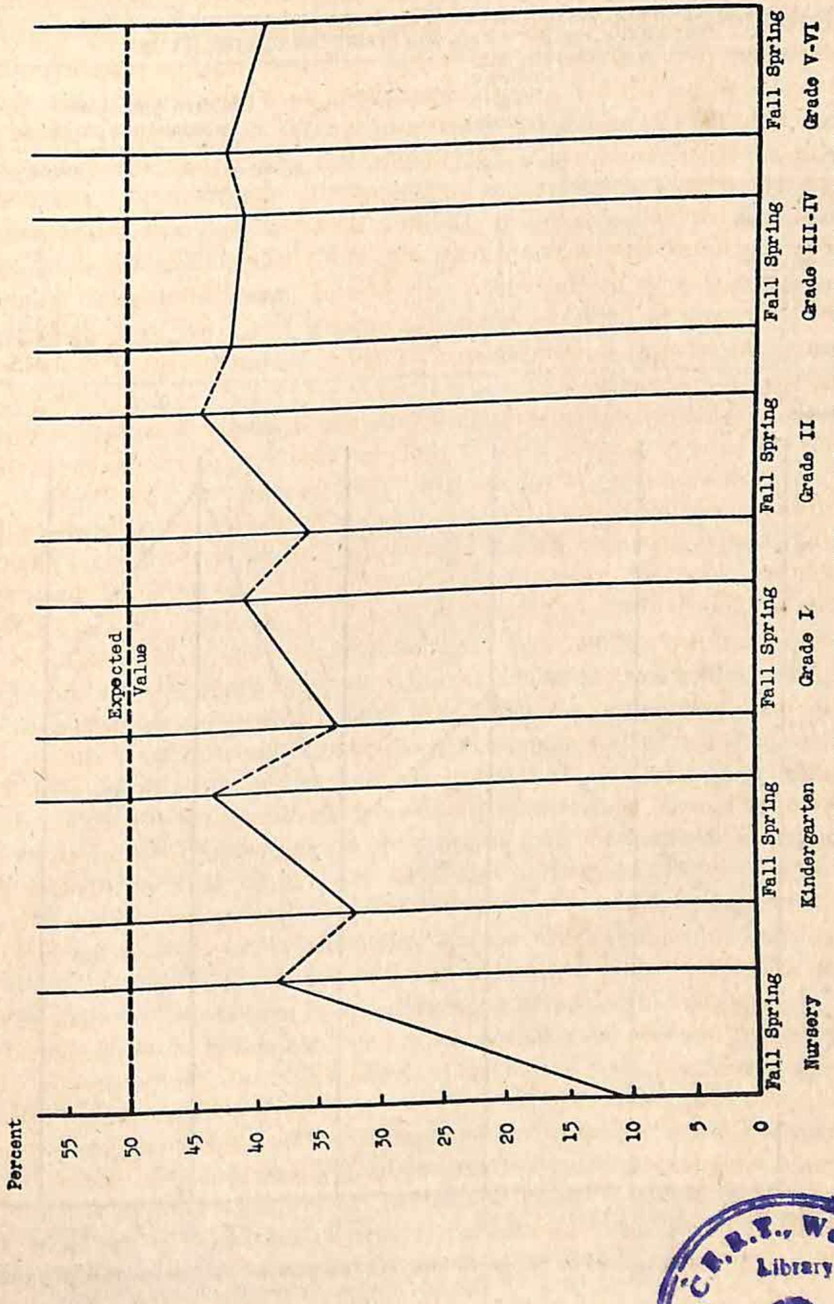

Fig. 1.—Percentage of Children Chosen in Excess of Chance Expectancy in Each Sociometric Test.

S.C.E.R.T., West Bengal
Library
Calcutta

TABLE IX

PERCENTAGE OF CHILDREN IN EACH GROUP WHO APPEAR WITHIN THE SAME RING OF THE SOCIOGRAMS FOR BOTH FALL AND SPRING SOCIOMETRIC TESTS

Group	Number of Children Appearing in Both Sociograms	Children Appearing in Same Ring of Both Sociograms	
		Number	Per Cent
Nursery	14	3	21
Kindergarten	20	6	30
Grade I	21	9	43
Grade II	14	5	31
Grade III-IV	29	18	62
Grade V-VI	29	13	45
Total	127	54	42.5

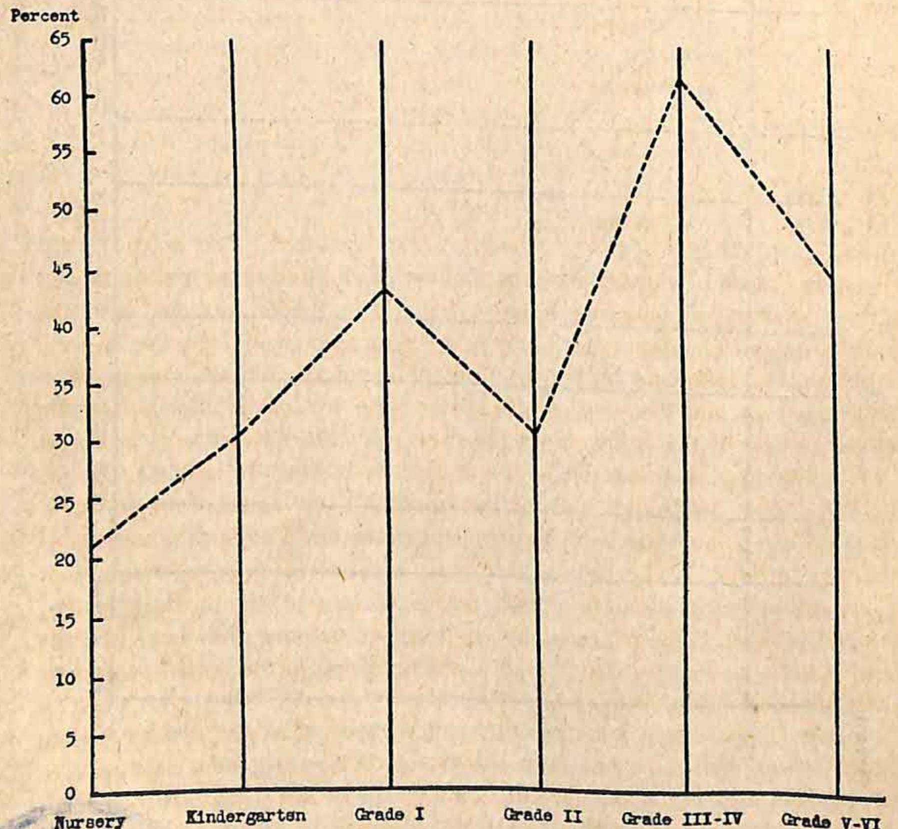

Fig. 2.—Percentage of Children in Each Group Who Appear within the Same Ring of the Sociogram for Both Fall and Spring Sociometric Tests.

distinct, is incorporated in the single percentage value for the combined class.

Isolation. Indices of isolation for each sociometric test are presented in Table X. To indicate the variable significance of a given number of isolates in groups of varying size, the number of children in each class as well as the frequency of observed isolates is given in the table along with the requisite index. The data from Table X are presented graphically in Figure 3. As before, the solid and broken portions of the curve differentiate between changes *within* and *between* grades. The solid horizontal line across the central portion of the chart shows the expected value. Deviations in excess of this value appear above the line; negative deviations are indicated below. The two broken horizontal lines delineate regions of statistical significance; events falling outside the band between these two lines have probabilities of chance occurrence of .02 or less. It will be observed that the number of isolates appearing in each sociometric test is, in general, significantly smaller than the number to be expected by chance, but that no pronounced trends are evidenced. Except in Grade II, a slight tendency for decrease of isolation *within* the grade may be noted.

TABLE X

PROBABILITIES OF CHANCE OCCURRENCE FOR OBSERVED NUMBER OF ISOLATED IN EACH SOCIOMETRIC TEST

Group	Time of Test	Size of Group	Number of Observed Isolates	Probability of Chance Occurrence
Nursery	Fall	18	1	.036
	Spring	16	0	.008
Kindergarten	Fall	25	2	.040
	Spring	21	1	.023
Grade I	Fall	26	0	.002
	Spring	22	0	.003
Grade II	Fall	18	0	.005
	Spring	14	1	.076
Grade III-IV	Fall	33	4	.068
	Spring	29	1	.009
Grade V-VI	Fall	31	1	.007
	Spring	31	0	.001

Neglect. Isolation is defined in terms of raw social status score. Thus its significance varies, as has been shown, in diverse sociometric situations. The question may be raised whether it would not be advantageous to investigate variations in the periphery of the sociogram in terms of a definition based on deviation from chance expectancy—a definition analogous to the

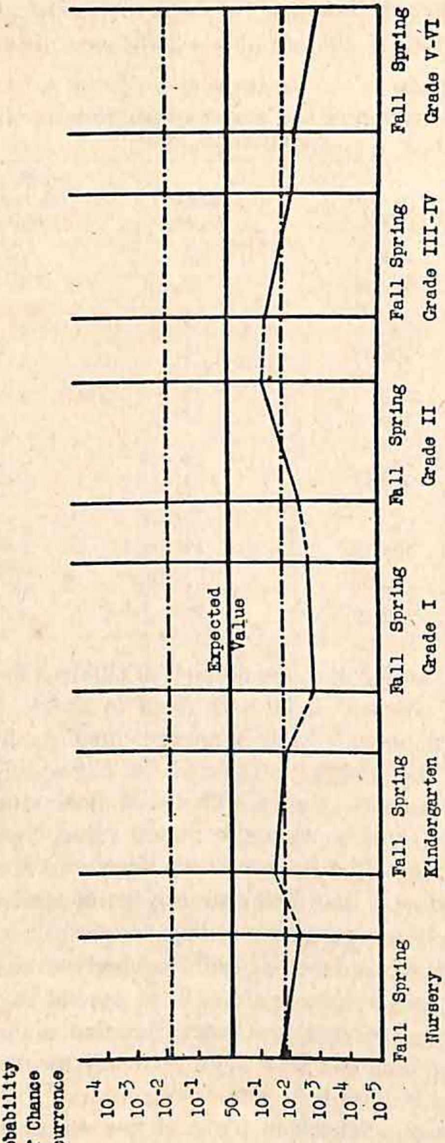

Fig. 3.—Probalities of Chance Occurrence for Observed Number of Isolates in Each Sociometric Test. — - — Levels of Significance.

one already proposed for Moreno's concept of *star*. Since the word "isolate" is not literally applicable, the term "neglectee" may be utilized in referring to all individuals in the outer ring of the sociogram—that is, all those who have received a number of choices so small as to be statistically significant. The proportions of such neglectees found in each sociometric test is given in Table XI and the data are presented graphically by line (B) in Figure 4.

TABLE XI
PERCENTAGE OF CHILDREN APPEARING AS NEGLECTEES IN EACH SOCIOMETRIC TEST

Group	Time of Test	Size of Group	Children Appearing as Neglectees Number	Per Cent
Nursery	Fall	18	7	39
	Spring	16	2	12
Kindergarten	Fall	25	9	36
	Spring	21	4	19
Grade I	Fall	26	5	19
	Spring	22	5	23
Grade II	Fall	18	0	0
	Spring	14	4	29
Grade III-IV	Fall	33	8	24
	Spring	29	6	21
Grade V-VI	Fall	31	7	22
	Spring	31	4	13
Total		284	61	21.5

It is of interest to note that, except in the middle range, this line is in measure a mirror image of the curve in Figure 1 and complements the generalization suggested by that graph. The proportion of neglectees tends to *decrease* as the members of the group become better acquainted and is likely to be smaller for older age groups.

Stardom. Consistent with the general tendencies thus far described are the trends revealed by an analysis of stardom. As shown in Table XII and Figure 4 (line A), the percentage of stars increases slightly in the primary grades. Moreover, if one proceeds to investigate the degree of deviation attained by individual stars, it becomes evident that, though stars cease to increase in frequency in the elementary grades, they continue to increase in intensity up to the sixth grade level. This is indicated by the data in Table XIII and Figure 5 which show the probability of chance occurrence for the highest number of choices attained by any one child in each sociometric test. Since the probability frequently approaches infinitesimal values, the standard

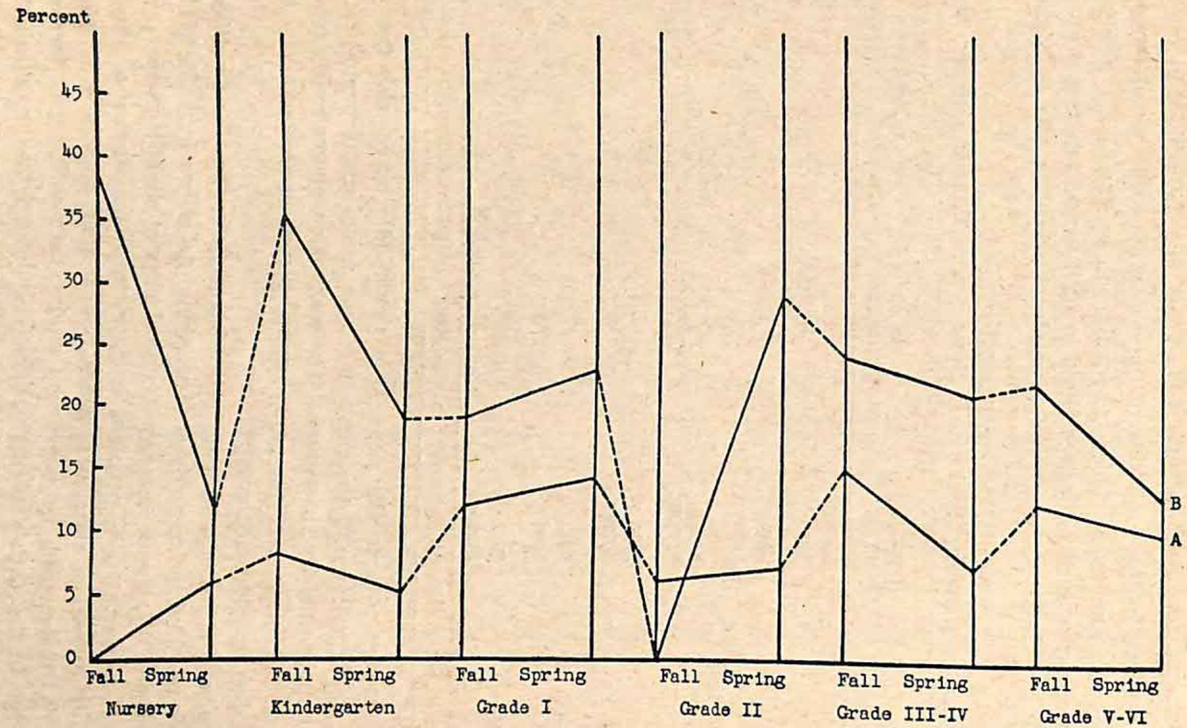

Fig. 4.—Percentage of Children Appearing as Stars (A) and Neglectees (B) in Each Sociometric Test.

TABLE XII

Percentage of Children Appearing as Stars in Each Sociometric Test

Group	Time of Test	Size of Group	Children Appearing as Stars	
			Number	Per Cent
Nursery	Fall	18	0	0
	Spring	16	1	6
Kindergarten	Fall	25	2	8
	Spring	21	1	5
Grade I	Fall	26	3	12
	Spring	22	3	14
Grade II	Fall	18	1	6
	Spring	14	1	7
Grade III-IV	Fall	33	5	15
	Spring	29	2	7
Grade V-VI	Fall	31	4	13
	Spring	31	3	10
Total		284	26	9.2

TABLE XIII

Standard Score Equivalents and Approximate Probabilities of Chance Occurrence for the Highest Number of Choices Received by Any One Person in Each Sociometric Test

Group	Time of Test	Size of Group	Highest Number of Choices Received by Any One Person	Standard Score Equivalent	Approximate Probability of Chance Occurrence
Nursery	Fall	18	10	+ .55	.28
	Spring	16	17	3.16	$2 \cdot 10^{-3}$
Kindergarten	Fall	25	23	5.16	$1 \cdot 10^{-5}$
	Spring	21	18	3.44	$1 \cdot 10^{-3}$
Grade I	Fall	26	23	5.15	10^{-5}
	Spring	22	22	4.86	$2 \cdot 10^{-5}$
Grade II	Fall	18	17	3.12	$2 \cdot 10^{-3}$
	Spring	14	16	2.85	$4 \cdot 10^{-3}$
Grade III-IV	Fall	33	21	4.38	$1 \cdot 10^{-4}$
	Spring	29	19	3.71	$4 \cdot 10^{-4}$
Grade V-VI	Fall	31	28	6.84	....
	Spring	31	33	8.60	....

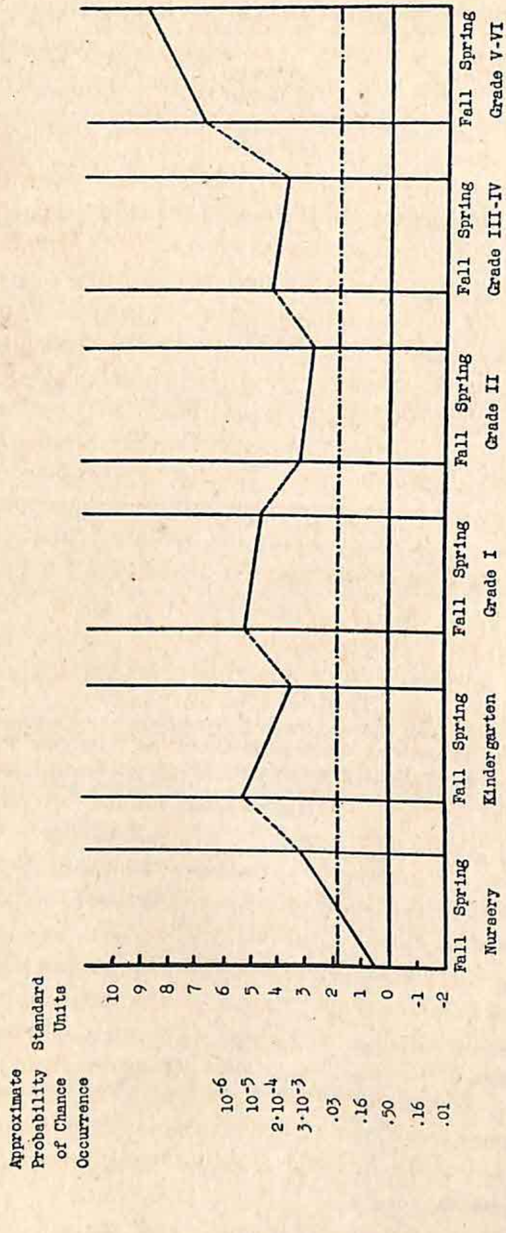

Fig. 5.—Standard Deviations and Probabilities of Chance Occurrence for the Highest Number of Choices Received by Any One Person in Each Sociometric Test.

— - - — Level of Significance.

score equivalents for the raw score values are given in the table, and to facilitate comparison of extreme deviations the ordinate axis of the graph has been calibrated in standard units.[31] As before, deviations significantly in excess of chance expectancy are shown above the broken horizontal line. The increase in intensity of stardom is clearly evidenced by the rise in the curve from left to right.

A further examination of Figure 5 reveals a secondary trend in the variation of intensity of stardom. In the graph, the solid portion of the curve displays a small but fairly consistent negative gradient; that is, *within* the grade the intensity of stardom tends to decrease slightly.

Taken together, the data on frequency and intensity of stardom prompt the following generalizations. The number of children commanding a large portion of their classmates' attention is relatively small (not above 15 per cent) and tends to increase slightly from one grade level to the next. The attention which the star commands also increases from class to class but appears to drop slightly *within* the grade. Finally, as clearly shown in Figure 4, the proportion of stars is almost without exception lower than the proportion of neglectees. This complements the evidence cited earlier to the effect that in sociometric situations negative deviations are more frequent than positive ones, though they are generally not as marked. The data suggest the conclusion that in classroom groups the proportion of overlooked or rejected children is greater than the proportion of children who are exceptionally popular and acceptable.

Coherence. An examination of sociometric data for the successive grades suggests that there is a gradual rise in degree of coherence as one passes from younger to older groups. The increase in number of mutual ties in the early grades is evident upon inspection. It will be noted further that while clique structures are present in the middle grades, by the V-VI level they become completely consolidated into two sub-groups—one for each sex.

The existence of the trend is further corroborated by the indices of coherence computed for the several groups. These values are given in Table XIV and are depicted graphically in Figure 6. Since the obtained probabilities frequently approach infinitesimal values, standard score equivalents for facilitating comparison of extreme deviations are again given both in the table and the graph. As before, the solid horizontal line across the central portion of the chart represents the expected value with deviations in excess of the value shown above the line and negative deviations below. Regions

---

[31] Comparison in terms of standard units is possible since the skewness is practically identical for all the distributions under consideration.

TABLE XIV

STANDARD SCORE EQUIVALENTS AND APPROXIMATE PROBABILITIES OF CHANCE OCCURRENCE FOR OBSERVED NUMBER OF MUTUAL CHOICES IN EACH SOCIOMETRIC TEST

Group	Time of Test	Size of Group	Number of Mutual Choices	Standard Score Equivalent	Probability of Chance Occurrence
Nursery	Fall	18	7	—1.86	—.02
	Spring	16	13	— .41	—.41
Kindergarten	Fall	25	20	+1.36	+.09
	Spring	21	24	2.53	.01
Grade I	Fall	26	19	1.32	.10
	Spring	22	21	1.80	.04
Grade II	Fall	18	38	6.44	...
	Spring	14	23	2.22	.02
Grade III-IV	Fall	33	55	10.70	...
	Spring	29	59	12.40	...
Grade V-VI	Fall	31	53	10.64	...
	Spring	31	57	11.74	...

of statistical significance (.02 or less) occur outside the band between the two broken lines. As will be noted from the graph, the index shows a definite increase in degree of coherence from the lowest to the highest grade. In the fall sociometric test for the Nursery, the number of mutual choices is so small as to be statistically significant; yet levels significantly *in excess* of chance expectancy appear as early as in the kindergarten and in Grade I, while beyond Grade II the probability of chance occurrence for the observed number of mutual choices becomes infinitesimal.[32]

A further inspection of Figure 6 suggests the more specific generalization that there is a consistent rise in degree of coherence *within* each group over the five to seven month period between tests. Only Grade II shows a drop in index for this interval, and as indicated before (page 46) special conditions of increased cleavage may account for this departure from the general trend.

---

[32] It is of interest to note that when, in the preliminary investigations, indices of coherence were computed on the basis of person-score rather than choice-score (see page 47), values markedly in excess of chance expectancy were not obtained. Indeed, in the fall sociometric tests for the Nursery, Kindergarten, and Grade I the values were so *small* as to be statistically significant; that is, despite the fact that in two of the groups (Kindergarten and Grade I—see Figure 22) the number of mutual bonds between *choices* exceeded chance expectancy by a good margin, the number of mutual bonds between *persons* was significantly *short* of the expected value. These facts suggest that while children may be involved in numerous reciprocated social relationships, these relationships involve a comparatively small number of different persons.

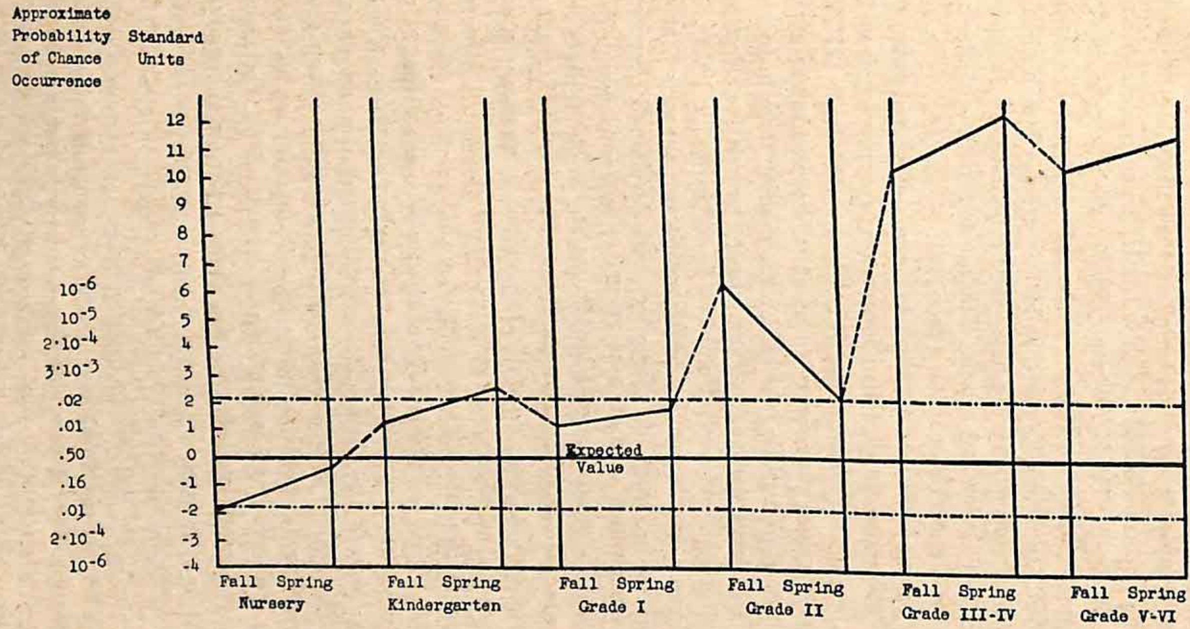

Fig. 6.—Standard Deviations and Probabilities of Chance Occurrence for Observed Mutual Choices in Each Sociometric Test. — - — - — Levels of Significance.

Consistent with the generalization cited is the tendency, evidenced in the sociograms, for clique structures appearing in the fall to become articulated and amalgamated by the time of the spring test. A marked exception to this trend occurs in Grade III-IV, where, despite the increase in index of coherence, distinct clique structures are more numerous in the spring than in the fall target. It would appear that in this group, though choices were reciprocated more frequently after a half-year's acquaintance, factors restricting the direction of choice had arisen. The possible nature of these factors is indicated in subsequent discussion (page 46).

The gradient in index of coherence *between* successive grade groups is not constant. The most conspicuous increases occur in passing from the first to the second-grade level, and in turn from this to the Grade III-IV group, the latter being the most pronounced index shift observed in the experiment. This increment is in part made possible by the marked drop in index within Grade II; a second contributive factor may be the cumulative effect produced by a combined group composed of children from two grade levels.

Sex Cleavage. An examination of the sociograms suggests that cleavage on the basis of sex increases for successive grade levels and becomes highly marked in the V-VI group. Except in Grade II, where cleavage in mutual choices first becomes complete, the trend *within* the group appears to be one of slightly increasing relationship between the sexes. These suggestions are borne out by a mathematical analysis of girl-boy and boy-girl choices. Indices for each type are presented in Table XV. Consistent with previous usage, the term "girl-boy" refers to girls' choices of boys; and conversely "boy-girl" refers to boys' choices of girls. The form of the table is identical with that of Table XIV save that, because of their infinitesimal magnitude, probabilities of chance occurrence have not been indicated. Trends in variation are more readily identified by reference to Figure 7 which presents results in graphic form. Indices for girl-boy choice are shown by line B; those for boy-girl choice, by line A. Since deviations are all negative, an increase in cleavage (decrease in inter-sex choice) is indicated in the graph by a drop from left to right. It will be noted that cleavage is present in a significant degree from the Nursery level on. Except in Grade III-IV, the general tendency is for girls to choose boys even less frequently than boys choose girls. The increase in cleavage *between* groups is fairly consistent—particularly for girl-boy choices. As suggested by inspection of the sociograms, a slight decrease in cleavage *within* the group appears in every class except Grade II, and possibly Grade V-VI. Grade II is the only group wherein a decrease in frequency of inter-sex choice occurs over the five- to seven-

TABLE XV

STANDARD SCORE EQUIVALENTS FOR OBSERVED NUMBER OF GIRL-BOY AND BOY-GIRL CHOICES IN EACH SOCIOMETRIC TEST

			Girl-Boy Choices		Boy-Girl Choices	
Group	Time of Test	Size of Group	Number	Standard Score Equivalent	Number	Standard Score Equivalent
Nursery	Fall	18	15	—6.23	16	—6.00
	Spring	16	20	—4.39	31	—1.73
Kindergarten	Fall	25	6	—9.21	20	—7.68
	Spring	21	20	—5.52	22	—6.17
Grade I	Fall	26	21	—7.49	40	—3.92
	Spring	22	23	—6.03	39	—2.48
Grade II	Fall	18	19	—5.64	10	—6.98
	Spring	14	5	—7.97	4	—7.05
Grade III-IV	Fall	33	1	—10.79	1	—13.59
	Spring	29	12	—8.77	12	—10.61
Grade V-VI	Fall	31	5	—13.72	5	—7.94
	Spring	31	5	—13.53	2	—8.90

month period between tests. It will be recalled that this group is also the first to show complete cleavage in mutual choices.

The disparity and crossing-over of indices for the two highest groups may be in part an artifact produced by the unequal proportion of boys and girls. As seen from Table XV the actual number of girl-boy and boy-girl choices is exceedingly small in both groups, while the ratio of girls to boys shifts from a very high to a very low proportion. It is this shift in ratio rather than a genuine reversal in inter-sex choice that is reflected by the indices. The difficulty cannot be avoided inasmuch as the number of subjects in each dichotomy fixes a ceiling for whatever type of index may be derived, and where the ratio is unequal the ceiling levels are necessarily unequal also.

An examination of the sociometric data reveals a somewhat unexpected reappearance of mutual choices between the sexes in the spring test for Grade III-IV. This is accompanied by a decided decrease in indices of inter-sex cleavage of both types. That these data reflect actual behavior is confirmed by the observations of the investigator and the reports of the teacher. It was indeed "spring": pre-adolescent "crushes" made their first appearance in this group during the second semester.

The fact that the degree of cleavage may be determined and altered in accordance with circumstance is further illustrated by the results obtained for the leadership criterion. Particularly at the V-VI level, where cleavage

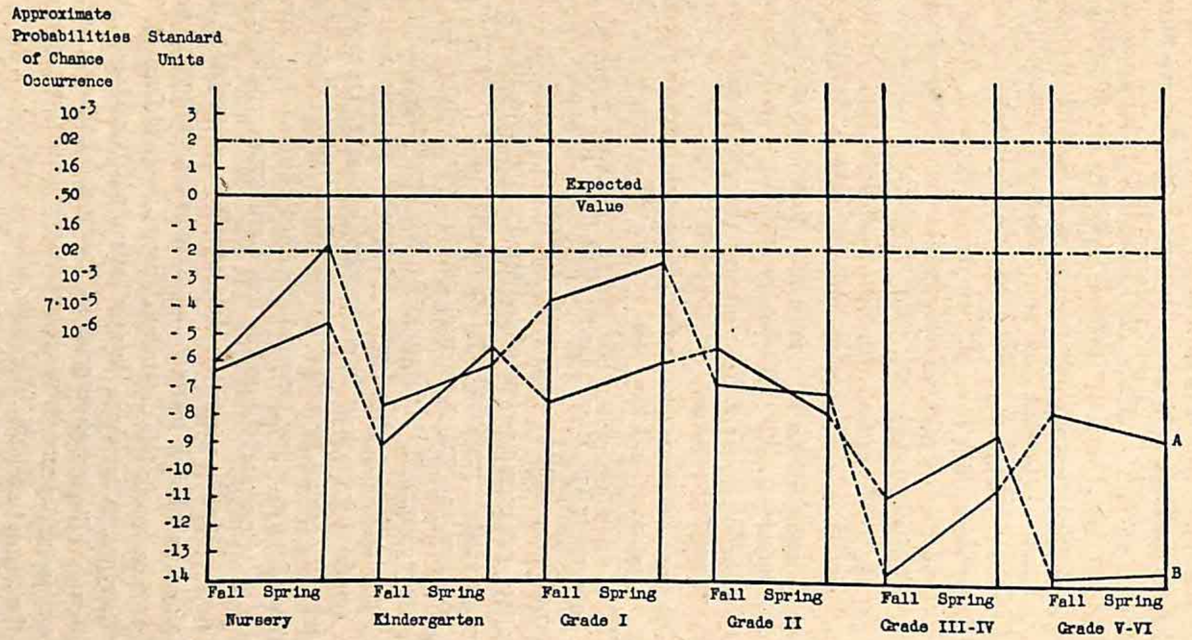

Fig. 7.—Standard Deviations and Probabilities of Chance Occurrence for Observed Boy-Girl (A) and Girl-Boy (B) Choices in Each Sociometric Test.

— - — - — Levels of Significance.

on the basis of the other criteria was almost complete, girls consistently picked boys in their selection of a leader.

It is of interest to note that the marked shifts in inter-sex cleavage observed in Grade II and Grade III-IV are accompanied by disturbances in other indices as well. It has already been pointed out, for example, that mutual choices show an unexpected drop at the second grade level. This is doubtless related to the disappearance of mutual choices between the sexes in that group. Other departures from general trends occurring at the second grade level are seen in Figures 2, 3, and 4 which portray degree of variation in constancy, isolation, and neglect.

In Grade III-IV, the paradoxical increase in clique structures accompanying the rise in degree of coherence (Figure 6) becomes meaningful when one considers the possible effects of rivalry and "intrigue" among children experiencing their first "crushes." The establishing of paired relationships between the sexes is not unlikely to break up the group into sets, each possessing a high degree of coherence within itself.

In summary, the data presented above suggest the following generalizations regarding cleavage between the sexes on the basis of criteria of work, play, and seating. A significant level of cleavage is apparent even at the nursery level. While acquaintance over a period of half a year appears to break down barriers to a slight degree, preference for the same sex continues to increase from grade to grade. A particularly pronounced rise in cleavage occurs at and about the second grade level. Departures from the general trend in the upper elementary grades, though they are produced in part by statistical artifacts, may presage a shift in the frequency and character of inter-sex choice accompanying adolescence.

Grade Cleavage. An inspection of the sociometric choices prompts the impression that in the combined groups, horizontal cleavage on the basis of grade is also present. To confirm this impression, indices for inter-grade choice were computed and are given in Table XVI. Graphical presentation of these data in Figure 8 reveals that a significant degree of cleavage is present in all sociometric tests for the combined groups. In Grade III-IV, the frequency of inter-grade choices increases over the five month period between tests (possibly a reflection of the rise in inter-sex choices, which cross grade lines indiscriminately). The gradient is reversed for the corresponding interval in Grade V-VI. In both groups, choices from the higher to the lower grade were even less frequent than choices from the lower to the higher.

TABLE XVI

Standard Score Equivalents and Probabilities of Chance Occurrence for Observed Number of Inter-Grade Choices within Combined Groups

			Choices from Lower to Higher Grade			Choices from Higher to Lower Grade		
Group	Time of Test	Size of Group	Number	Standard Score Equivalent	Probability of Chance Occurrence	Number	Standard Score Equivalent	Probability of Chance Occurrence
Grade III-IV	Fall	33	37	—5.76	....	20	—9.84	...
	Spring	29	35	—4.56	$3\cdot10^{-6}$	31	—6.71	...
Grade V-VI	Fall	31	56	—2,67	$4\cdot10^{-3}$	40	—4.99	...
	Spring	31	49	—3.93	$4\cdot10^{-5}$	28	—6.93	...

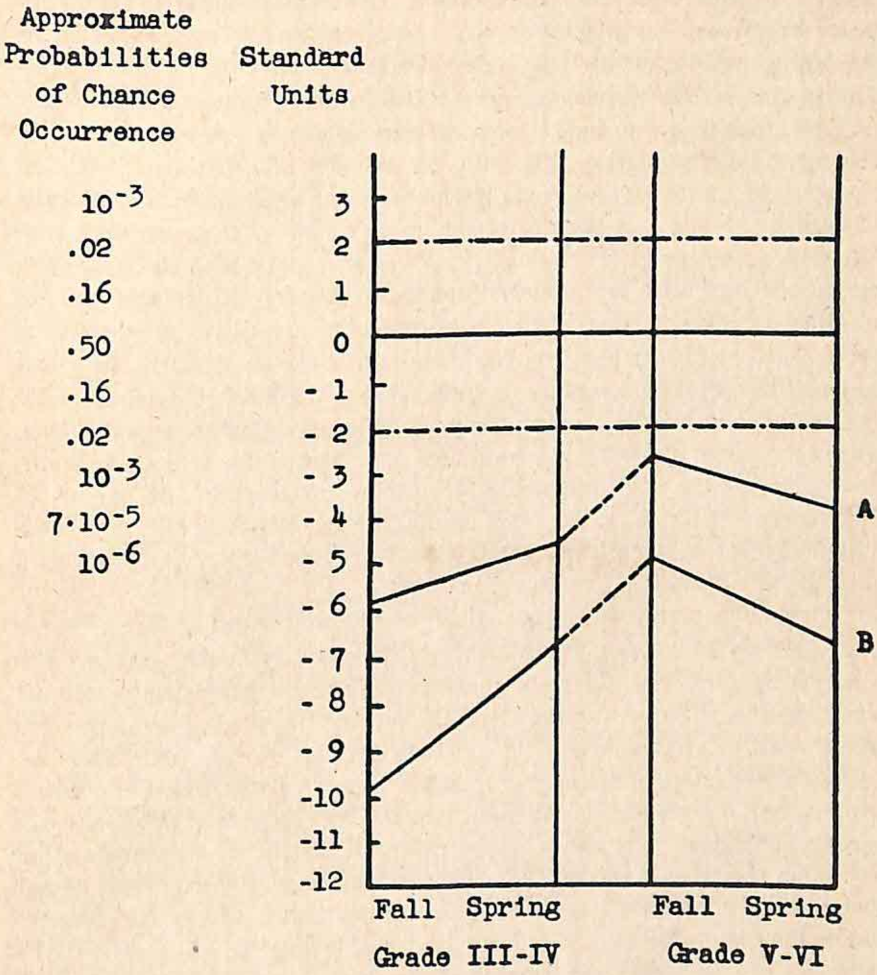

Fig. 8.—Standard Deviations and Probabilities of Chance Occurrence for Observed Inter-Grade Choices within Combined Groups.

A—Choice from the Lower to the Higher Grade.
B—Choice from the Higher to Lower Grade.
— - — - — Levels of Significance.

SECTION 3

Simplified Methods for Applying Refined Sociometric Techniques

It cannot be denied that the mathematical knowledge and skill required for computing and interpreting refined indices of sociometric status, coherence, and cleavage are such as to make the methods impractical for general use by teachers, psychologists, and social workers. Fortunately, however, experience from the present study suggests that, once certain limits of applicability are defined, several of the basic techniques may be divested of their mathematical complexities without too great a loss in the accuracy of results. For example, with regard to indices of sociometric status, it was observed in the course of experimentation that with the number of criteria and allotted choices held constant (each equal to three), levels of significance were little affected by variation in the size of the group. Thus whether the class consisted of sixteen or of thirty-three persons, a raw score of 3 choices, represented the limit of statistical significance for minimal occurrence; that is, at either extreme of group size, a raw score of 3 or less was so small as to be expected by chance less than two times in a hundred; similarly, for either group, a raw score of 15 choices corresponded to the limit of significance for events in excess of chance expectancy. Further investigation revealed that, except for values above 15, any given raw score had, within reasonable limits, approximately the same probability of chance occurrence in any one of the twelve sociometric tests. In other words, little accuracy would have been lost had the raw score itself, rather than the probability index, been used directly as a measure of sociometric status.

Additional mathematical analysis by methods described in Part I showed that such conditions of comparability obtain generally in the most common sociometric situations where the number of choices allotted per person for each criterion is no greater than five, the number of criteria does not exceed three, and the groups include no less than ten and no more than fifty persons.[33] Provided the number of criteria and choices allotted are held constant from group to group, levels of significance are little influenced by variation in size and any given score below the upper limit of significance represents about the same degree of deviation from chance expectancy. Consequently, though not suitable for detailed or carefully controlled study, within the indicated limits the *raw status score* affords a fairly reliable index of sociometric status. If levels of significance are determined in advance, raw scores may be used directly in the construction of sociometric targets with areas delineated in terms of deviation from chance expectancy. In order to make the preparations of such sociograms possible, the raw score values corresponding to limits of significance for the most common sociometric situations are given in Table XVII. The table and its use are described below.

---

[33] In current sociometric practice, the number of criteria or choices allotted rarely exceed the values cited above. It is possible that even when as many as four or five criteria are utilized, conditions of comparability will still obtain within acceptable limits, particularly if the groups contain no less than twenty-five or thirty persons. Actual computation of probabilities (by reference to the Pearson Type III Curve) would be necessary to verify the fact, and this may be done should occasion for so elaborate a sociometric test arise.

In Table XVII, types of sociometric situation are defined in terms of the number of choices allotted per person for each criterion and the number of criteria. For each type of sociometric setting the following data are given: (1) the expected value or mean score, which indicates the raw score to be represented on the target by the second circle (counting from the center); (2) the raw score corresponding to the limit of statistical significance for events falling *short* of chance expectancy; (3) the raw score corresponding to the limit of statistical significance for events occurring *in excess* of chance expectancy.[34] To cite an illustration: consider a sociometric situation in which *two questions* have been asked and the subject requested to name *three persons* as associates for each of the two activities described in the questions; that is, there are *two* criteria with *three* choices allotted per person for each. Reference to Table XVII under the column headed "Two Criteria" reveals that under such conditions the number of choices a person is most likely to receive by chance is 6, that a raw score of 1 or less is so small as to be statistically significant, and that a score of 11 or more is significantly in excess of chance expectancy. Thus in the construction of the sociogram, persons with scores of 11 or greater are placed in the innermost circle and classified as stars, those with scores of 1 or less are placed in the outermost ring and classified as neglectees, and the remainder are distributed in the two intermediate rings with persons scoring above six in the inner of the two rings and those scoring below six in the outer one.

TABLE XVII

CRITICAL RAW STATUS SCORE VALUES FOR DIVERSE SOCIOMETRIC SITUATIONS

Number of Choices Allotted to Each Person for Each Criterion	One Criterion			Two Criteria			Three Criteria		
	Expected Value	Critical Scores Lower Limit	Critical Scores Upper Limit	Expected Value	Critical Scores Lower Limit	Critical Scores Upper Limit	Expected Value	Critical Scores Lower Limit	Critical Scores Upper Limit
1	1	None	4	2	None	6	3	0	8
2	2	None	6	4	0	9	6	1	12
3	3	0	7	6	1	11	9	3	15
4	4	0	8	8	2	13	12	5	18
5	5	1	9	10	4	16	15	9	22

The considerations outlined above are similarly applicable to indices of coherence. In groups varying in size from about ten to fifty persons, the probability that a given number of mutual choices will occur by chance is relatively unaffected provided the number of criteria and choices allotted remains fixed. Consequently, the sheer number of mutual choices observed may be utilized directly with reasonable confidence as a fairly reliable index of group coherence. Raw score values corresponding to limits of significance for the more common types of sociometric situation are given in Table XVIII.

---

[34] The limits of significance are not absolutely identical for all groups. While generally in the neighborhood of .02 or .03, they may rise as high as .05 in groups numbering fewer than about fifteen or more than thirty-five persons.

TABLE XVIII

CRITICAL RAW MUTUAL CHOICE SCORE VALUES FOR DIVERSE SOCIOMETRIC SITUATIONS

Number of Choices Allotted Each Person for Each Criterion	One Criterion Critical Scores		Two Criteria Critical Scores		Three Criteria Critical Scores	
	Lower Limit	Upper Limit	Lower Limit	Upper Limit	Lower Limit	Upper Limit
1	None	3	None	4	None	6
2	None	7	0	10	1	13
3	0	10	3	17	7	23
4	3	15	9	26	16	36
5	7	21	16	37	27	53

The table is of the same form as Table XVII and is interpreted in similar manner. For example, given the conditions of three criteria with five choices allotted for each, 53 or more observed mutual choices are significantly in excess of chance expectancy while 27 or fewer mutual choices fall significantly short of the expected value. When obtained, such extreme scores would suggest respectively the presence and absence of group solidarity.[35]

Unfortunately, indices of group cleavage, since they are a function of the ratio between sizes of sub-groups, cannot be reduced to simplified raw score equivalents. If cleavage is to be studied without recourse to probability indices perhaps a practicable if not rigorous method is that of determining the ratio of inter-class choices to the total number of choices available—for example, the proportion between the number of girl-boy choices and the total number of choices made by girls. Difficulties will be encountered, however, in determining the significance of a given ratio.

In summary, for sociometric situations involving as many as three criteria with five choices allotted per person, the total number of choices received by each child may be used with reasonable confidence as a reliable index of sociometric status provided the number of criteria and choices allotted remains constant for all groups tested; similarly, the total number of mutual choices may be utilized for the comparative study of group coherence. Once differential levels of choice are established, results may be depicted graphically on a target and an analysis made of the proportion of neglectees, stars, etc. Used in conjunction with indices of coherence these data will permit comparison between groups and identification of trends.

---

[35] The values in Table XVII of course apply only when mutual choice is defined in terms of relationship between *choices* on the same criterion.

SECTION 4

Conclusions

In the light of the discussion and evidence submitted in the course of this paper, certain generalizations appear warranted. The generalizations are of two general types: those pertaining to technique, and those pertaining to experimental results.

I. Technique

Conclusions with regard to technique may be regarded as fairly well established. They include the following:

1. Social status, structure, and development may be studied effectively by means of refined mathematical techniques adapted for use in diverse sociometric situations.

2. The concept of deviation from chance expectancy provides a basis for deriving indices which may be used for the estimation and comparison of social status of the degree of coherence within social groups, and of the extent of group cleavage on the basis of such factors as sex, age, race, nationality, or similar attributes.

3. Definition of sociometric status and structure in terms of deviation from chance expectancy (e.g. neglectees and stars) permits identification of trends otherwise obscured.

4. Certain of the techniques developed may be divested of their mathematical complexities and are thus adaptable for general use by teachers, psychologists, and social workers. Specifically, within established limits, raw sociometric scores may be legitimately utilized for the comparative and longitudinal study of individual status and group coherence.

II. Experimental Results

The generalizations derived from the experimental results are, for the most part, to be regarded as suggestive rather than final. They represent conclusions to be verified and principles to be taken into account in subsequent definitive research. The generalizations may be conveniently classified under the three major topics: status, structure, and development.

1. *Status*

5. *Components of Sociometric Status.* The components of sociometric

status, determined by the specific criteria utilized, are generally interrelated; that is, persons considered desirable as associates in one situation are generally considered desirable in other situations as well. However, considerable variation may occur in individual instances. These facts are indicated by the magnitude of correlation coefficients between ranks on the several criteria taken separately.

6. *Neglect and Rejection.* In classroom sociometric situations, a few persons are chosen so seldom in comparison with chance expectancy as to confirm the existence of social forces of neglect or reception.[36]

7. *Stardom.* In classroom sociometric situations, a few persons are chosen so far in excess of chance expectancy as to confirm the existence of social forces of acceptance and attraction.[37]

2. *Structure*

8. *Distribution of Status.* In classroom sociometric structures, negative deviations in social status are more frequent, though not as extreme, as positive deviations. Two major manifestations of this trend were observed in the present study: (1) Fewer than half the children in each group were chosen in excess of chance expectancy, but when so chosen they received a markedly undue proportion of the available choices; (2) Though an equal number would have been expected on the basis of chance, the proportion of neglectees was generally greater than the proportion of stars.

---

[36] The terms "neglect" and "rejection" are both used advisedly. A phase of the experimentation which, for lack of space, cannot be reported here in detail involved clinical observation and case studies of all children in the six groups. This investigation revealed that, while a variety of factors may be associated with extreme negative sociometric deviation, it is infrequently accompanied by inferior mental and academic status, by marked asocial behavior, and by general psychological immaturity. Two types of deviates were found—those who actively manifested offensive or undesirable behavior and were consciously *rejected* by their classmates, and those who were so inconspicuous and colorless as to be simply overlooked or *neglected*. Rigid classification, however, is hazardous; the clinical evidence indicated rather strongly that the factors making for inferior social status were manifold and interwoven into complex patterns. In the final analysis, the individual case study provides the best approach to the understanding of the genesis of sociometric inferiority.

[37] Though the trend was not as marked as in the case of negative social deviates, clinical evidence showed that the stars were generally among the brighter and more accomplished children in the class. They exhibited a minimum of asocial behavior and were generally recognized by adults as happy, well-liked, and well-adjusted. Once again, the variety and complexity of circumstances and traits accompanying extreme (in this case, positive) sociometric deviation point to the individual case study as the *sine qua non* for determining the psychological significance of sociometric results.

9. *Coherence.* In classroom sociometric situations, the frequency of mutual choices is usually so far in excess of chance expectancy as to confirm the existence of social forces of group coherence or solidarity. Occasionally, in groups composed of very young children, the number of reciprocated selections may be small enough to indicate a state of social disorganization and disjunction.

10. *Sex Cleavage.* In classroom sociometric structures, a marked degree of cleavage along sex lines is generally shown. In the groups studied, a division on the basis of sex was present at significant levels in all classes from Nursery to Grade V-VI. This was with respect to criteria of work, play, and seating only; for girls, cleavage was not present with respect to the criterion of leadership.

11. *Grade Cleavage.* Classes which have been separate for a period of years and are then merged into combined groups, preserve an integrity and discreteness of social structure even after a five month interval. This was demonstrated by the high indices of grade-cleavage secured in the two amalgamated groups—Grade III-IV and Grade V-VI.

3. *Development*

The conclusions concerning developmental change in social status and structure are derived jointly from cross-sectional and longitudinal data. While the same generalizations were usually indicated by both types of material, secondary fluctuations were occasionally perceived within the more pronounced primary trends.

A. PRIMARY TRENDS

12. *Frequency of Positive Social Deviation.* In classroom situations, the size of the minority commanding a relatively large proportion of attention increases as the members of groups become better acquainted and more mature. This tendency was manifested in the experimental results by the increase, as one passed from lower to higher grade levels, in the proportion of stars and in the percentage of children falling within the second circle of the sociogram.

13. *Intensity of Positive Social Deviation.* In classroom situations, the amount of attention commanded by persons who are centers of attraction becomes increasingly great in older age groups. This trend was reflected in the experimental results by the increase in degree of deviation for the most conspicuous star at each successive grade level.

14. *Frequency of Negative Social Deviation.* In classroom situations, the percentage of children rejected or neglected by their classmates decreases

as the members of the group become better acquainted and more mature. While some of these children are drawn more closely into the group, the decrease is produced in part by the undue proportion of *withdrawals* among negative social deviates, particularly at the primary grade levels. Evidence in support of this generalization has already been mentioned in Paragraph 13. It may be supplemented by citing the decrease, as one passes from lower to higher grade levels, in the percentage of neglectees, and the high ratio of withdrawals for the two outermost rings of sociograms for the Nursery, Kindergarten and Grade I groups.

15. *Coherence.* In classroom situations the degree of group solidarity increases as the members of groups become better acquainted and more mature. This was evidenced in the experimental results by the rise in index of coherence for successive grade levels. The increase indicated that older children were involved in stronger mutual relationships with a greater number of their classmates.

16. *Sex Cleavage.* In classroom groups, the degree of sex cleavage increases as groups become older. The increase is inconsistent and subject to considerable variation. This was indicated in the experimental results by the curves in Figure 7.

17. *Constancy in Status.* In classroom situations, marked shifts in sociometric status are comparatively rare. On the whole, children tend to retain the same general social position and this tendency becomes more pronounced in older age groups. These generalizations were evidenced by the following experimental results: Of over 125 children included in the study, not one shifted across more than two rings of the target during the period of the study. The proportion of subjects moving over as many as two rings was not more than 10 per cent, and the ratio of children remaining in the same area of the target increased for successive grade levels.

18. *Variation in Status.* Apart from changes *within* the individual, social status is not without its dynamic aspects. As clearly indicated by the primary and secondary trends reported in this section, various positions in the social structure are accompanied by positive or negative *valence*. The individuals occupying these positions will, over a period of time, exhibit a shift in status engendered by forces within the social structure itself. In view of this fact, complete status constancy is not to be expected, and variation in status must be interpreted not only in terms of change in individual social or psychological adjustment, but also in terms of group developmental trends.

19. *Interdependence of Structure.* Developmental trends in social status and structure are interdependent. Thus an irregularity in one aspect

of group development, such as social coherence, may be merely the reflection of a marked but consistent change in the degree of sex cleavage. Such interdependence was evidenced in the experimental results for Grade II.

20. *Inconsistency in Development Trends.* Both primary and secondary trends are subject to irregularities. Such departures may frequently be related to specific social circumstances or clinical events. For example, the unexpected drop in sex cleavage shown in Grade III-IV is understandable in the light of the clinical report concerning the appearance of pre-adolescent "crushes".

B. Secondary Trends

21. *Differentiation of Criteria.* In sociometric situations, as the members of the group become better acquainted, discrimination on the basis of activity in the selection of associates becomes slightly more pronounced. This was evidenced in the experimental results by the decrease, after a half-year period, in the magnitude of rank correlation coefficients between raw sociometric scores on the basis of the several criteria taken separately.

22. *Intensity of Stardom.* As members of groups become better acquainted, the amount of attention commanded by persons who are centers of attraction decreases slightly. This trend was manifested in the experimental data by the drop in intensity of stardom within groups over the half-year period between tests.

23. *Degree of Isolation.* In classroom sociometric situations, the amount of isolation, as revealed by an index based on deviation from chance expectancy, decreases slightly as members of the group become better acquainted.

24. *Sex Cleavage.* In classroom sociometric situations, the frequency of desired association between the sexes increases slightly as the members of the group become better acquainted. However, the degree of sex cleavage remains significantly high.

C. Summary

Classroom groups composed of older children show greater social solidarity than younger age groups. In the former, negative social deviates have either been eliminated or been more closely absorbed into the group structure; positive social deviates are both more frequent and more marked. In the upper elementary classes, sex cleavage becomes very pronounced. At all levels, the group structure becomes more compact as the members of the group become better acquainted. All of the above developmental trends are interdependent and subject to irregularity in direction and intensity.

* * *

In sum, the proper evaluation of social status and structure requires the envisagement both of the individual and the group as developing organic units. Piecemeal analysis, fixed in time and space, of isolated aspects and attributes is insufficient and even misleading, for the elements of social status and structure are interdependent, organized into complex patterns, and subject both to random and lawful variation.

BIBLIOGRAPHY

References on Sociometric Theory, Technique and Experimentation

1. Barker, Roger G. "The Social Interrelations of Strangers and Acquaintances." *Sociometry,* V (May, 1942).
2. Bordon, Ruth. "The Use of the Psychodrama in an Institution for Delinquent Girls." *Sociometry,* III (January, 1940). (Based on work at Bedford.)
3. Criswell, Joan Henning. "A Sociometric Study of Race Cleavage in the Classroom." *Archives of Psychology,* 33, No. 235, 1939.
4. Dubin, R. "The Measurement of Social Status." (Letter to the Editor.) *American Journal of Sociology,* XLV (April, 1940).
5. Jennings, Helen H. "Control Study of Sociometric Assignment." *Sociometric Review.* New York State Training School for Girls, Hudson, New York, 1936.
6. ———. "Structure of Leadership—Development and Sphere of Influence." *Sociometry,* I, Part 1 (July-October, 1937).
7. ———. *Leadership and Isolation: A Study of Personality in Inter-Personal Relations.* New York: Longmans, Green and Co., 1943. Pp. 240.
8. Johnson, Alvin D. "Sociometric Testing with Summer Camps." Mimeographed at Brown University, Providence, 1939.
9. Loomis, Charles P. "The Development of Planned Rural Communities." *Rural Sociology,* III (December, 1938).
10. Loomis, Charles P., & Davidson, Dwight M., Jr. "Sociometrics and the Study of New Rural Communities." *Sociometry,* II (January, 1939).
11. Lundberg, George A. "Social Attraction-Patterns in a Rural Village: A Preliminary Report." *Sociometry,* I, Part I (July-October, 1937).
12. Lundberg, George A., & Steele, Mary. "Social Attraction Patterns in a Village." *Sociometry,* I, Part II (January-April, 1938).
13. Moreno, J. L. *Who Shall Survive? A New Approach to the Problem of Human Interrelations.* Washington, D. C.: Nervous and Mental Diseases Publishing Co., 1934. Obtainnable at New York: Beacon House, Inc.
14. ———. "Inter-Personal Therapy and the Psychopathology of Inter-Personal Relations." *Sociometry,* I (July-October, 1937); Psychodrama Monograph No. 16, Beacon House, New York.
15. ———. "Psychodramatic Shock Therapy—A Sociometric Approach to the Problem of Mental Disorders." *Sociometry,* II (January, 1939), Psychodrama Monograph No. 5, Beacon House, New York.

16. ———. "Psychodramatic Treatment of Psychoses." *Sociometry,* III (April, 1940), Psychodrama Monograph No. 14, Beacon House, New York.
17. ———. "Mental Catharsis and the Psychodrama." *Sociometry,* III (July, 1940), Psychodrama Monograph, No. 6, Beacon House, New York.
18. ———. "Sociometry and the Cultural Order." *Sociometry,* VI (August, 1943), Sociometry Monograph No. 2, Beacon House, New York.
19. Moreno, J. L., & Jennings, Helen H. "Spontaneity Training, A Method of Personality Development." *Sociometric Review,* 1936, Psychodrama Monograph No. 4, Beacon House, New York.
20. ———. "Advances in Sociometric Technique." *Sociometric Review,* 1936, Sociometry Monograph No. 7, Beacon House, New York.
21. ———. "Statistics of Social Configurations." *Sociometry,* I, Part II (January-April, 1938), Sociometry Monograph No. 3, Beacon House, New York.
22. Newstetter, W. I., Feldstein, M. J., & Newcomb, T. M. *Group Adjustment: A Study in Experimental Sociology.* Cleveland: School of Applied Social Sciences, Western Reserve University, 1938.
23. Northway, Mary L. "A Method for Depicting Social Relationships Obtained by Sociometric Testing." *Sociometry,* III (April, 1940).
24. ———. "Appraisal of the Social Development of Children at a Summer Camp." *University of Toronto Studies, Psychology Series,* Vol. V, No. 1, 1940.
25. *Sociometry: A Journal of Inter-Personal Relations.* New York: Beacon House, Inc. (Published Quarterly.)
26. *Sociometric Review.* Issued in 1936. Obtainable at New York: Beacon House, Inc.
27. Vreeland, Francis McL. "Social Relations in the College Fraternity." *Sociometry,* V (May, 1942).
28. Wolman, Shepard. "Sociometric Planning of a New Community." *Sociometry,* I, Part I (July-October, 1937).
29. Zeleny, Leslie Day. "Sociometry of Morale." *American Sociological Review,* IV (December, 1939).
30. ———. "Measurement of Status." *American Journal of Sociology,* January 1940.
31. ———. "Rejoinder" (Letter to the Editor). *American Journal of Sociology,* XLV (April 1940).

References on Mathematical Theory and Technique

32. Bernoulli, J. *Ars conjectandi, opus posthumun,* 1713. (A German translation is found in Ostwald's *Klassicher der exakten Wissenschaften,* Nos. 107 and 108).
33. Camp, B. H. "Probability Integrals for the Point Binomial." *Biometrika,* XVI (1924), 163-71.
34. ———. *The Mathematical Part of Elementary Statistics.* Boston: D. C. Heath Co., 1931.

35. Fisher, R. A. *Statistical Methods for Research Workers* (Seventh Edition). London: Oliver and Boyd, 1938.

36. Garrett, H. E. *Statistics in Psychology and Education* (Second Edition). New York:

37. Glover J. W. *Tables of Applied Mathematics, Finance, Insurance, Statistics.* Ann Arbor, Michigan: George Wahr, 1933.

38. Kenney, J. F. *Mathematics of Statistics* (Parts I and II). New York: D. Van Nostrand Company, Inc., 1939.

39. Lindquist, E. F. *A First Course in Statistics.* Boston: Houghton Mifflin Company, 1938.

40. Pearson, K. "Contributions to the Mathematical Theory of Evolution—II. Skew Variation in Homogeneous Material." *Philosophical Transactions of the Royal Society of London* (Series A), LXXXVI (1895), 343-414.

41. ———. *Tables of the Incomplete* Γ *Function.* London: His Majesty's Stationery Office, 1922.

42. ———. *Tables for Statisticians and Biometricians.* Part I (Second Edition) and Part II. Cambridge University Press, 1924 (Part I) and 1931 (Part II).

43. ———. *Tables of the Incomplete Beta Function.* Cambridge University Press, 1934.

44. Peters C. C., & Van Voorhis, W. R. *Statistical Procedures and Their Mathematical Bases.* New York: McGraw-Hill Book Company, Inc., 1940.

45. Poisson, S. D. *Recherches sur la probabilité des jugements.* Paris, 1837.

46. Rietz, H. L. (Editor.) *Handbook of Mathematical Statistics.* Boston: Houghton Mifflin Company, 1924.

47. Salvosa, L. R. *Generalizations of the Normal Curve of Error.* Ann Arbor, Michigan: Edwards Brothers, Inc., 1930.

48. ———. "Tables of Pearson's Type III Function." *Annals of Mathematical Statistics,* I (1930). (Also published separately as *Tables for Statisticians.* Ann Arbor, Michigan: Edwards Brothers, Inc., no date.)

49. Shook, B. L. "Synopsis of Elementary Mathematical Statistics." (A Presentation in Abstract Form of the Lectures on this Subject Given by Professor H. C. Carver.) *Annals of Mathematical Statistics,* I (1930), Nos. 1 and 3.

50. Yule, G. U., & Kendall, M. G. *An Introduction to the Theory of Statistics* (Twelfth Edition, Revised). London: J. B. Lippincott Co., 1940.

S.C.E.R.T., West Bengal
Library
25/3, B. C. Road
Calcutta

360
M835

PSYCHODRAMA MONOGRAP

- No. 1. Sociodrama, A Method for the Analysis of Social Co Moreno (List Price—$1.25)
- No. 2. Psychodramatic Treatment of Performance Neurosis—J. (List Price—$1.50)
- No. 3. The Theatre for Spontaneity—J. L. Moreno (List Price—$2.50)
- No. 4. Spontaneity Test and Spontaneity Training—J. L. Moreno (List Price—$1.50)
- No. 5. Psychodramatic Shock Therapy—J. L. Moreno (List Price—$1.50)

163

- No. 6. Mental Catharsis and the Psychodrama—J. L. Moreno (List Price—$1.50)
- No. 7. Psychodramatic Treatment of Marriage Problems—J. L. Moreno (List Price—$1.50)
- No. 8. Spontaneity Theory of Child Development—J. L. Moreno and Florence B. Moreno (List Price—$2.00)
- No. 9. Reality Practice in Education—Alvin Zander, Ronald Lippitt and Charles E. Hendry (List Price—$1.50)
- No. 10. Psychodrama in the Schools—Nahum E. Shoobs (List Price—$1.50)
- No. 11. Psychodrama and Therapeutic Motion Pictures—J. L. Moreno (List Price—$1.50)
- No. 12. Role Analysis and Audience Structure—Zerka Toeman (List Price—$1.25)
- No. 13. A Case of Paranoia Treated Through Psychodrama—J. L. Moreno (List Price—$1.50)
- No. 14. Psychodrama as Expressive and Projective Technique—John del Torto and Paul Cornyetz (List Price—$1.25)
- No. 15. Psychodramatic Treatment of Psychoses—J. L. Moreno (List Price—$1.50)
- No. 16. Psychodrama and the Psychopathology of Inter-Personal Relations —J. L. Moreno (List Price—$2.00)

SOCIOMETRY MONOGRAPHS

- No. 1. Developments in Social Psychology, 1930-1940, Leonard S. Cottrell, Jr., and Ruth Gallagher (List Price—$1.50)
- No. 2 Sociometry and the Cultural Order—J. L. Moreno (List Price—$1.25)
- No. 3. Sociometric Measurement of Social Configurations—J. L. Moreno and Helen H. Jennings (List Price—$1.50)
- No. 4. Foundations of Sociometry—J. L. Moreno (List Price—$1.25)
- No. 5. Group Method and Group Psychotherapy—J. L. Moreno (List Price—$1.50)
- No. 6. A Constant Frame of Reference for Sociometric Research—Urie Bronfenbrenner (List Price—$2.25)
- No. 7. Sociometric Control Studies of Grouping and Regrouping—J. L. Moreno and Helen H. Jennings (List Price—$1.25)

Orders should be accompanied by check, money order or cash
and sent to:
BEACON HOUSE
101 Park Avenue
New York 17, N. Y.